THE

EMPORIUM

OF

ARTS AND SCIENCES.

VOL. II. APRIL, 1814. No. III.

STEAM ENGINE.

(Concluded.)

I HAVE not procured the specification of which the following is an extract. I copy the Monthly Magazine for October, 1811, vol. 32, p. 255.

Mr. Arthur Woolf's Patent, for improvements in the construction and working of Steam Engines, calculated to lessen the consumption of fuel.

THE nature of this invention may be thus described: The working cylinder of the steam engine has no bottom, but is enclosed in another cylinder of such dimensions, that the space between the two, which space is called the receiver, is equal to at least the contents of the working cylinder. The enclosing cylinder has a bottom, and the two cylinders are joined together at the top by flanghes, or any other suitable means, and the lower rim of the working cylinder is about as far distant from the inclosing cylinder as the distance between the sides of the two cylinders. Instead of having a void space for receiving

steam below the piston, Mr. W. introduces below it, and into the receiver, such a quantity of oil, &c. as shall, when the piston is at its greatest height, in the working cylinder, fill all the space below it, and fill also the receiver up to the height of a few inches above the lower rim of the working cylinder. If the engine is to be worked by the pressure of the atmosphere, the receiver has a communication with the boiler, which communication being opened, steam is admitted into, and fills the receiver above the oil. If the communication between the receiver and the boiler be now shut off, and a communication be opened from the receiver to the condenser, a vacuum will be formed in the receiver, and then the pressure of the atmosphere, acting upon the piston, will cause it to descend in the working cylinder, pressing the oil, or other fluid body, before it, and causing the fluid to ascend into the receiver; after which the steam is again admitted for the next stroke. If the engine is to be worked by the action of the steam upon the piston, then the working cylinder must, as is usual in steam engines so worked, be furnished with a cover. In this case, instead of the communication usual in the engines in common use, for the alternate admission and condensation of steam above and below the piston, the communications in this engine are to the upper part of the working cylinder, and to the upper part of the receivers, the receiver in the engine answering to the space below the piston in other steam engines; so that, when the receiver is open to the condenser, and the upper part of the working cylinder open to the boiler, the piston ascends, and vice versâ. To prevent waste of steam, and to keep up the temperature of the oil, the receiver may be enclosed in a steam case, or heat may be applied externally. There should always be some oil above the piston to the height of a few inches, to prevent the passage of the atmospheric air, or of the steam, down-

wards, by the side of the piston. To prevent any deviation of the quantity of oil by the working of the engine, means must be provided to restore it to the requisite height, as cocks, valves, &c. regulated by a float or floats upon the surface of the oil, or by means of a pump or pumps worked by the engine itself, or otherwise. By the interposition of the oil, between the piston and the condenser, all waste of steam, by passing the piston, is effectually prevented, and a consequent saving of fuel is effected.

Woolf's method of measuring the elastic force of Steam.

PLATE I. of this number exhibits a measured section of the self-acting and regulating steam valve. A A represents the upper part of the boiler, having its mouth or neck cylindrical, and closed by a well-fitted, but easily moving valve plug, B B C C, which is in fact a metallic tube, open at bottom and closed above, by a cap-piece B B, that by its chamfered rim or projecting part affords the accurate valve-closure when down. The interior parallel lines at D shew the place where a long perforation is made through the side of the cylindrical part of the valve plug from its cap, nearly down to the bottom; which perforation affords a passage for the steam, increasing in magnitude as the elastic force causes the valve to rise. E is the side passage for conveying the steam to its place of operation. F is the rod or tail of the valve passing through a stuffing box above, and attached by a chain to the sector G, and by its means moving the lever that carries the ball H.

The above constitutes the whole of this simple and effectual contrivance, and its mode of operation scarcely needs to be described. As the steam becomes stronger it raises the valve, and escapes through D, and raises the weight H higher the more the pressure within exceeds that of the working steam in the upper space F E.

On Mr. Arthur Woolf's *improved apparatus, applicable to Steam Engines and other purposes of art and manufacture: including a description of two boilers now erecting at Messrs.* Meux's *Brewery.*

MR. WOOLF'S improved apparatus consists, First, of two or more cylindrical vessels properly connected together, and so disposed as to constitute a strong and fit receptacle for water, or any other fluid intended to be converted into steam, whether at the usual heats or at temperatures and under pressures uncommonly high; and also to present an extensive portion of convex surface to the current of flame, or heated air or vapour from a fire: Secondly, of other cylindrical receptacles placed above these cylinders, and properly connected with them, for the purpose of containing water and steam, and for the reception, transmission, and useful application of the steam generated from the heated water or other fluid: and, Thirdly, of a furnace so adapted to the cylindrical parts just mentioned, as to cause the greater part of the surface of all and each of them, or as much of the said surface as may be convenient or desirable, to receive the direct action of the fire, or heated air and vapour.

That our readers may be able fully to comprehend the way in which Mr. Woolf constructs his apparatus, we shall present some plans and views, with such a description as will, we hope, convey a pretty correct idea of their nature.

Fig. 1. (Plate II.) represents one of his boilers in its most simple form. It consists of eight tubes marked *a*, made of cast iron or any other fit metal, which are each connected with the cylinder A placed above them, as shown in the side view fig. 2, in which the same letters refer to the same parts as in fig. 1. In fig. 2. is also shown the way in which the fire is made to act. The fuel rests on the bars at B, and the flame, heated air and vapour, being reverberated from the part above the two

first smaller cylinders, goes under the third, over the fourth, under the fifth, over the sixth, under the seventh, and partly over partly under the eighth small cylindric tube. The direction of the flame, till it reaches the last-mentioned tube, is shown by the dotted curved line and arrows. When it has reached that end of the furnace it is carried by the flue C to the other side of a wall, built under and in the direction of the main cylinder A, and then returns under the seventh smaller cylinder, over the sixth, under the fifth, over the fourth, under the third, over the second, and partly over partly under the first; when it passes into the chimney. The wall before mentioned, which divides the furnace longitudinally, answers the double purpose of lengthening the course which the flame and heated air have to traverse, giving off heat to the boiler in their passage, and of securing from being destroyed by the fire the flanges or other joinings employed to unite the smaller tubes to the main cylinder. The ends of the smaller cylindric tubes rest on the brick-work which forms the sides of the furnace, and one end of each of them is furnished with a cover, secured in its place by screws or any other adequate means, but which can be taken off at pleasure, to allow the tubes to be freed, from time to time, from any incrustation or sediment which may be deposited in them. To any convenient part of the main cylinder A, a tube is affixed, to convey the steam to the steam-engine, or to any vessel intended to be heated by means of steam.

When very high temperatures are not to be employed, the kind of boiler just described is found to answer very well; but where the utmost force of the fire is desirable, Mr. Woolf, for a reason which shall be afterwards mentioned, combines the parts in a manner somewhat different, though the same in principle. Having been permitted to inspect two boilers of this kind which he is now

erecting in Messrs. Meux's* brewery, and even to take copies of such parts of the plans as were necessary for our present purpose, we persuade ourselves a short description of an apparatus so curious, and at the same time so useful, will prove highly acceptable to our readers.

In fig. 3, A is the main cylinder crossing the smaller cylinders *a*, *a*, *a*, half way between their middles and ends, but not joined to them at the points at which it crosses them. It is put in this place that it may come over that part of the furnace S, S, S, through which the flame first passes, and receive its direct action, which it does over nearly a half of its surface, as may be seen by looking at the vertical section A S S, fig. 6. The smaller cylinders have a communication with the main cylinder in the following manner :—Three cylinders, CCC, are placed parallel to the main cylinder A, over the part of the furnace by which the flame returns, in such a manner that each of the cylinders CCC takes in three of the smaller cylinders *a a a*, being united to and connected with them as shown in fig. 4, which is a longitudinal vertical section of that part of the apparatus. The cylinders CCC have a direct communication with the main cylinder A by the pipes or tubes P P P, as may be better seen by the cross vertical section, fig. 6, in which the same parts are marked with the same letters as in figures 3 and 4. The three tubes CCC are preferred to one long tube, to prevent any derangement taking place in the furnace or in the tubes, by the expansion and contraction, occasioned by changes of temperature, which is more considerable in one tube of the whole length of the furnace, than when divided into three portions; and it is for the same reason that the tube A is not made to communicate directly with the smaller tubes *a a a*, but mediately by means of the tubes marked C and P.—N. B. The two outermost of the tubes marked P, instead of going parallel to the middle tube P,

* The Meux's, are the greatest Porter Brewers in England.

may both be inclined towards it, as one of them is from *m*, so as to join the cylinder A near the middle; or any other direction may be given to them, to prevent derangement by expansion.

The tubes C and *a* are kept from separating by bolts from the inside of *a* passing through the top of C, where they are secured by nuts screwed on to them (see fig. 5.); and these parts of C are so contrived, that by taking off any of the nuts a cover may be removed, and a hole presented large enough to admit a man's hand into C to clean it out.

Fig. 5 is a longitudinal vertical section of the boiler and furnace, through the centre of the axis of the main cylinder A, showing the course which the flame and heated air are forced to take. The first three small cylinders are completely surrounded with flame, being directly over the fire: the flame is stopped by the brick-work W over the fifth, and forced to pass under it, and then over the sixth, where it again meets with an interruption, which forces it to go under the seventh, over the eighth, and partly over partly under the ninth. It then turns round the end of the longitudinal wall which divides the furnace, and passes over the eighth smaller cylinder, under the seventh, and so on alternately over and under the other tubes, till it reaches the chimney B, fig. 4. The wall that divides the furnace may be seen in fig. 3, N, N, and in fig. 6, at N.

To secure a free communication between the different parts of the boiler, the three tubes of the middle cylinder C are connected with those of the two exterior C's by two pipes *o o*. The other ends of the tubes *a a a* are each fitted with a cover properly secured and bolted, but which can be taken off occasionally to clean out the boiler.

In working with such boilers, the water carried off by evaporation is replaced by water forced in by the usual

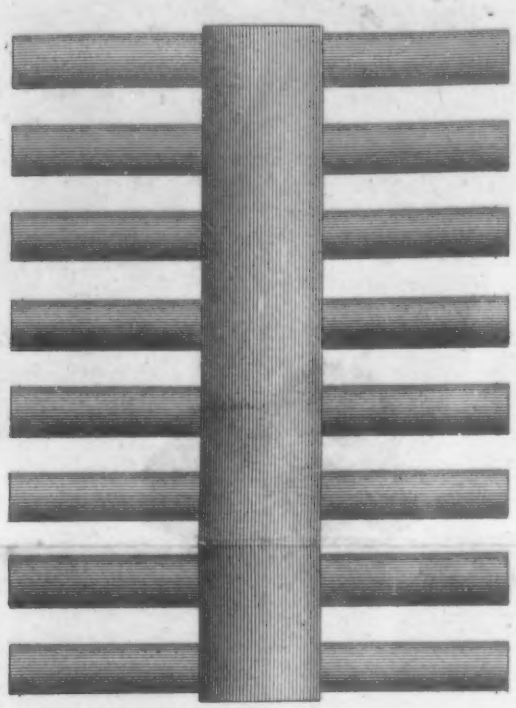
means; and the steam generated is carried to the place intended, by means of tubes connected with the upper part of the cylinder A.

Mr. Woolf has taken out a patent for this very valuable contrivance. In the specification he has lodged of his invention, means are pointed out for applying it to the boilers of steam-engines already in use, by ranging a row of cylinders below the present boiler, and connecting them with each other and with the boiler. Directions are also given for constructing boilers composed of cylinders disposed vertically; but as we consider such an arrangement inferior to the horizontal, and as being introduced, perhaps, chiefly for the purpose of preventing his patent from being infringed by evasion, we shall not give any further description of it. We cannot, however, dismiss this article without quoting some of Mr. Woolf's remarks, which may prove very useful.

"It may not be improper (says he) to call the attention of those who may hereafter wish to construct such apparatus to one circumstance, namely, that in every case the tubes composing the boiler should be so combined and arranged, and the furnace so constructed, as to make the fire, the flame and heated air to act around, over and among the tubes, embracing the largest possible quantity of their surface. It must be obvious to any one that the tubes may be made of any kind of metal; but I prefer cast iron as the most convenient. The size of the tubes may be varied: but in every case care should be taken not to make their diameter too great; and it must be remembered, that the larger the diameter of any single tube in such a boiler the stronger must it be made in proportion, to enable it to bear the same expansive force as the smaller cylinders. It is not essential, however, to my invention that the tubes should be of different sizes; but I prefer that the upper cylinders, especially the one which I call the

Mr. Woolf's Boiler.

1



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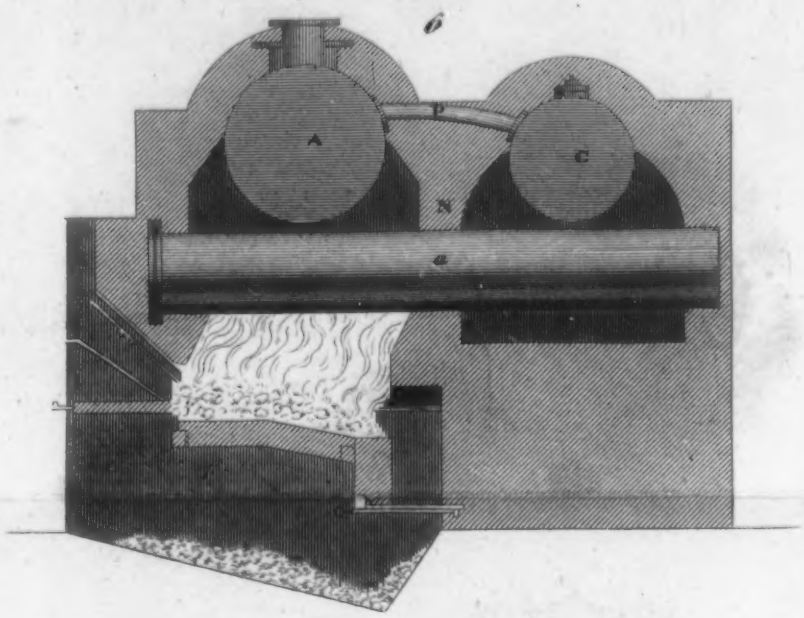

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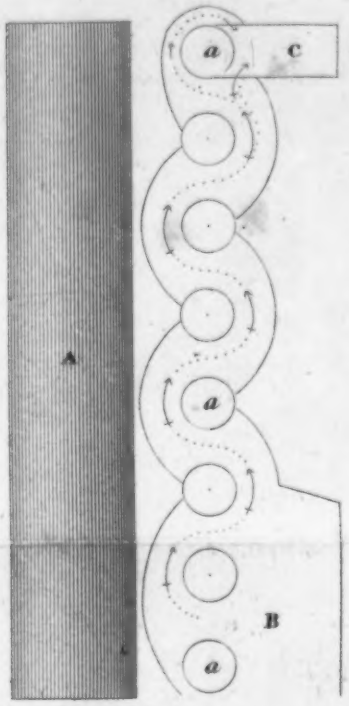

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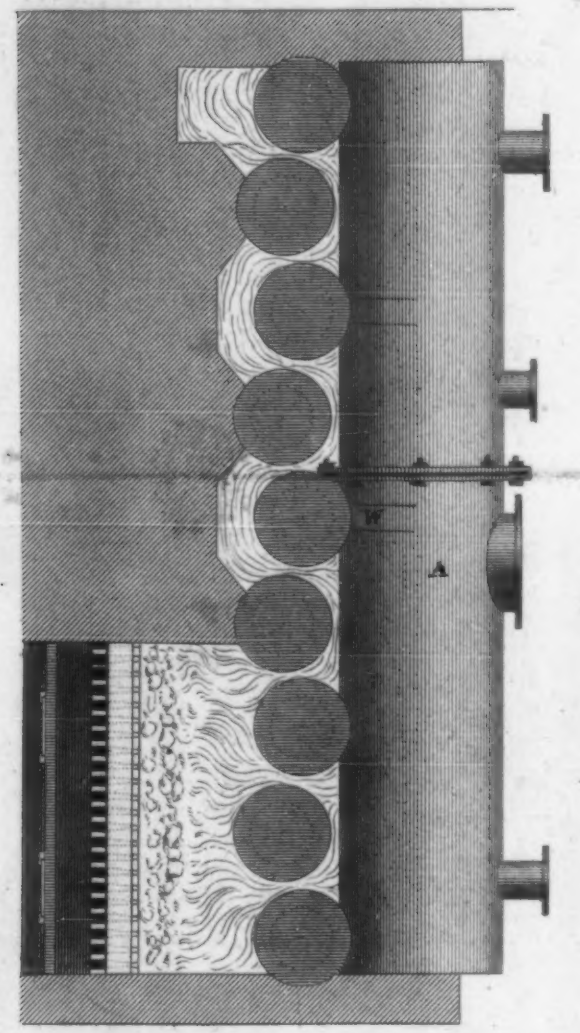

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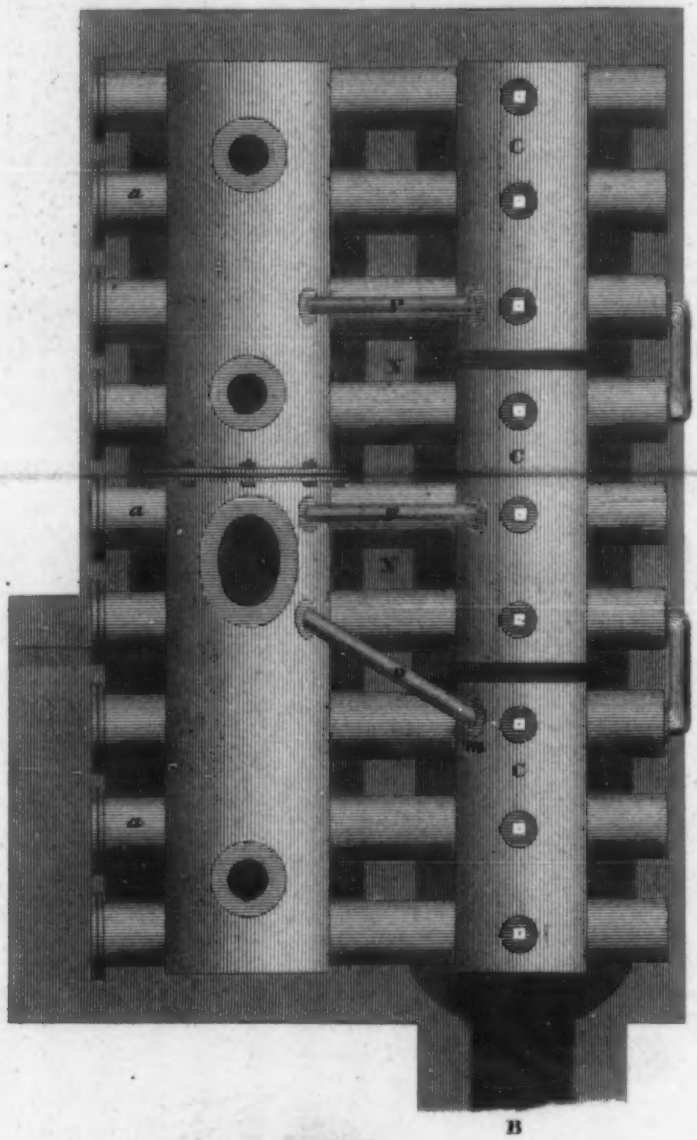

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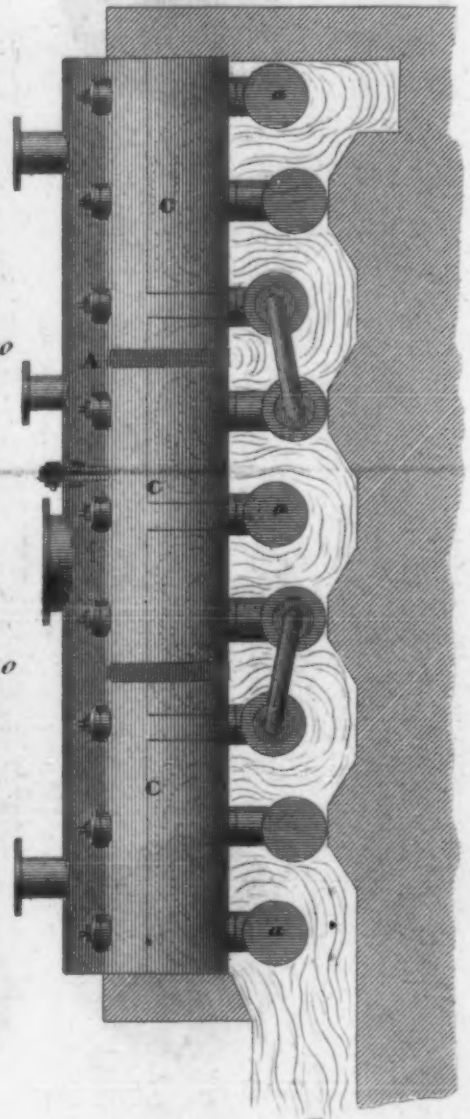

½ Inch to a Foot.

Tiebout Sc.

main cylinder, should be larger than the lower ones, it being the reservoir as it were into which the lower ones send the steam, to be thence conveyed away by the steam pipe or pipes. The following general direction may be given respecting the quantity of water to be kept in a boiler on my construction:—it ought always to fill not only the lower tubes, but the main cylinder A and the cylinder C to about half their diameter; that is, as high as the fire is allowed to reach—and in no case ought it to be allowed to get so low as not to keep full the necks or branches which join the smaller cylinders, marked with the letter *a*, to the cylinders A or C; for the fire is only beneficially employed when applied, through the medium of the interposed metal, to water, to convert it into steam: that is, the purpose of my boiler would in some measure be defeated, if any of the parts of the tubes exposed to the direct action of the fire should present in their interior a surface of steam instead of water, to receive the transmitted heat, which must more or less be the case if the lower tubes, and even a part of the upper, be not kept filled with the liquid.

"As to the construction of the furnaces, though that must be obvious from the drawings, it may not be improper here to remark that they should always be so built as to give a long and waving course to the flame and heated air, or vapour, forcing them the more effectually to strike against the sides of the tubes which compose the boiler, and so to give out a large portion of their heat before they reach the chimney: unless this be attended to, there will be a much greater waste of fuel than necessary; and the heat communicated to the contents of the boiler will be less from a given quantity of fuel.

"My invention is not only applicable to all the uses to which the boilers in common use are generally applied, but to all of them with much better effects than the latter,

and can besides be applied to purposes in which boilers, constructed as they have hitherto been, would be of little or no use. The working of all kinds of *steam engines* is one important application of my invention; for the steam may be raised, in a boiler constructed in the manner before described, to such a temperature, and consequently to such an expansive force, as to work an engine even without condensing the steam, by simply allowing it to escape into the atmosphere after it has done its office, as proposed by Mr. James Watt, in the specification of his patent, dated January 5, 1769: where he says, engines may be worked by the force of steam only, by discharging the steam into the open air. In all cases where it is desirable to heat or boil water, or other fluids and substances, without the direct application of fire to the vessel or vessels containing them, which in such cases become secondary boilers, the use of my apparatus will produce effects superior to any obtainable by other means—no more being necessary than to make the vessel, or secondary boiler, containing the water or other fluids, and the substances immersed or dissolved in, or blended or mixed with the water or other fluid, to communicate, by means of a tube or tubes, with the prime boiler, constructed in the manner before described. In such cases, as in making extracts of every kind for the various purposes of arts and manufactures, and for the simple boiling of water or watery fluids, the steam should go directly into the vessel, or secondary boiler, whose contents are to be heated or boiled; and the orifice or orifices of the pipe or pipes through which the steam is conveyed should go to a considerable depth in the fluid, that the steam may be the better able to give off its heat and be condensed before it can reach the surface: and in every such case, an allowance should be made for the increase which will be made to the quantity of liquid in the vessel to be heated,

by the quantity of steam which will be condensed in the same before the process be ended. The vessels into which the steam is thrown may be either open or close, as the nature of circumstances may require: but where extracts are to be made from vegetable or other matters from which extracts are or may be made, as from hops, bark, drugs and dye-stuffs, for brewing, tanning, dyeing and other processes, the materials will be much more completely exhausted of all their valuable parts; and in many instances they will be completely dissolved by employing close vessels, which in that case must be made very strong,—a thing not difficult to be accomplished, when it is recollected that they may be at a distance from, and consequently out of the power of being deranged by, the fire, and that they may be surrounded with, and as it were buried in, massy stone or brick-work, in addition to other and obvious means of securing them. My apparatus so employed becomes, in fact, an improved Papin's digester on a large scale. I do not wish to be understood as claiming the merit of having been the first who applied steam in the manner just described to boil water and other fluids, but merely as pointing out an important use to which my apparatus is applicable, and in which the effect obtained will be much greater than by any other means.

"Another important use to which my invention can be applied with better effect than the means now in use, is that of *distillation* on the large scale, and that by either sending the steam directly into and among the contents of the still or alembic, or by inclosing the still in another vessel, and making the steam of a high temperature, to circulate in and to occupy the space between the exterior surface of the still and the interior surface of the containing vessel. In either case, all danger of burning or singeing the materials operated upon is done away, and a much more pleasant and pure spirit will be obtained than by the

methods now in common use. I need not stop here to shew the reason why, even in the case of throwing the steam directly into the still, the spirituous part will be the first to rise and pass over into the receiver.

"I might mention many other useful applications that may be made of my invention; but I shall only state one more, namely, to the drying of *gunpowder*, and lessening the danger of explosions in the manufacture of that article. By means of my invention, any desired temperature, necessary for that purpose, may be produced where the powder is to be dried, without the necessity of having fire in, or so near the place as to endanger its safety; for by employing steam only, conveyed through pipes, and properly applied and directed, without allowing any of it to escape into the room or apartment where the powder is, any competent workman can produce a heat equal to that found necessary for drying gunpowder, or much higher if required. Nor is the lessening of the danger of explosions the only advantage which this way of drying gunpowder holds out—it presents another and an essential one for the goodness of the article—the heat can be completely regulated so as to prevent, or at least lessen, the partial decomposition of the powder by the sublimation of the sulphur, which is found to take place by the methods at present in use."

In every case Mr. Woolf uses two safety valves at least, in his apparatus, to prevent accidents: a precaution which cannot be too strongly enforced; as it may happen, when but one is employed, it may by some accident get locked, and the works and people about them be exposed to the danger of an explosion.

Besides the common safety valves, Mr. Woolf has also introduced a valve, of a new construction, into the steam-pipe itself, to regulate the quantity that shall pass from the boiler. In fact, it is a self-acting regulator; and

being extremely ingenious, we think we shall be gratifying our readers by laying a description of it before them, which we shall in our next, with an accurate engraving.*

The two boilers now constructing for Messrs. Meux will not be the least curious part of the immense collection of ingenious mechanism of which their premises can boast. They are not intended for the steam engine, but to supercede the necessity of applying fire directly to their two large boilers, each of which are of the contents of about 800 barrels. They are in future to be heated by steam, sent into them from these new boilers; which will not only prevent the wear to which the coppers are exposed by the usual practice, which costs a large sum of money yearly, but, it is expected, will produce a large saving in fuel.

We understand also, that when these boilers are finished Messrs. Meux mean to have one constructed for their steam engine. Indeed, if these boilers shall be found to answer the purposes expected from them, and we can see no reason to induce us to doubt of their success, it will occasion a complete change in numerous departments of arts and manufactures, in which steam and the heat that may be obtained from it are, or may be, advantageously employed.†

Description of Mr. Arthur Woolf's improved Piston for Steam-Engines.

THE common method of packing the piston of a steam engine is so well known, that a very particular description of it in this place is not necessary. Suffice it to say, that the hollow part round the piston, is filled

* Already given in this number.

† Mr. Woolf has adopted for the door of his furnace Mr. Robertson's invention for consuming smoke. See beginning of this volume.

with rounds of hemp or cotton, loosely spun or twisted, which is pressed into a pretty compact form by a ring, which is worked down by screws distributed round the ring and working into the body of the piston; by which means the packing is made to fill the diameter of the cylinder pretty closely, and to prevent, while the packing remains sound, any steam from passing between the piston and the cylinder. In the usual method, whenever the piston, by continued working, becomes too easy, and so occasions a waste of steam, it is necessary to take off the top of the cylinder, even when fresh hemp or cotton is not wanted, merely to get at the screws, which serve to force the upper ring nearer to the bottom of the piston, by which means the packing is forced outwards against the side of the cylinder. This is heavy laborious work, and is therefore generally shunned by the man that attends the engine, as long as the engine can possibly be made to work without taking this trouble; and in consequence of this neglect a great and unnecessary waste of steam is occasioned, and a waste of fuel in proportion.

Mr. Woolf's improvement on the piston is such as to enable the engine-man to tighten the piston without the necessity of taking off the cover of the cylinder, except when new packing becomes necessary. He accomplishes this by either of the two following methods:

He fastens each of the screws into a small wheel, which are all connected with each other by means of a central wheel, which works loose upon the piston-rod in such a manner, that if one of the small wheels be turned, it turns the central wheel, and the latter turns the other four. The one that is to be first turned is furnished with a projecting square head, which rises up into a recess in the cover of the cylinder. This recess is surmounted by a cap or bonnet, which being easily taken off, and as easily put again in its place, there is little difficulty in screw-

ing down the packing at any time. The parts are so clearly expressed in the plates that no further description is necessary to make any person comprehend it.

The other method is similar in principle, but a little different in construction. Instead of having several screws all worked down by one motion, there is in this but one screw, and that one is a part of the piston-rod: on this is placed a wheel of a convenient diameter, the centre of which is furnished with a female screw. This wheel is turned round, *i. e.* screwed down by means of the pinion, which is furnished with a square projecting head rising into a recess of the kind already described. The ring is prevented from turning with the wheel by means of two steady pins.*

Description of a Safety Valve, containing a Vacuum Valve in the same Hole of the Boiler. By Sir A. N. EDELCRANTZ.†

IN large boilers or coppers, where boiling fluids are enclosed, a *safety valve* is generally used to prevent their bursting, from an unexpected excessive force of the elastic steam, and, besides, a *vacuum valve*, to prevent their being compressed or crushed by the weight of external air, in the case of a sudden condensation of the vapours. These two valves are commonly fitted in two different holes in the boiler; but as a more simple, and consequently more eligible, method seems to be that of joining them together, I take the liberty to submit to the Society for the Encouragement of Arts, &c. the following contrivance for that purpose:—

a b, Plate III. Fig. 2. is a common conical safety valve,

* There is a plate describing this in 26 Phil. Mag. 317, which I have not thought it necessary to copy. T. C.

† From the Memoirs of the Society of Arts for 1804. The silver medal was awarded for this invention.

with rounds of hemp or cotton, loosely spun or twisted, which is pressed into a pretty compact form by a ring, which is worked down by screws distributed round the ring and working into the body of the piston; by which means the packing is made to fill the diameter of the cylinder pretty closely, and to prevent, while the packing remains sound, any steam from passing between the piston and the cylinder. In the usual method, whenever the piston, by continued working, becomes too easy, and so occasions a waste of steam, it is necessary to take off the top of the cylinder, even when fresh hemp or cotton is not wanted, merely to get at the screws, which serve to force the upper ring nearer to the bottom of the piston, by which means the packing is forced outwards against the side of the cylinder. This is heavy laborious work, and is therefore generally shunned by the man that attends the engine, as long as the engine can possibly be made to work without taking this trouble; and in consequence of this neglect a great and unnecessary waste of steam is occasioned, and a waste of fuel in proportion.

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fixed in the boiler *c d*, having four openings, *i i*, which are represented in a plain view in *Fig.* 3: *e f* is the metallic rod, bearing the weight K K, with which the safety valve is loaded, and extending itself under that valve to *f*: *g h* is the *vacuum valve* consisting in a plane circular plate, with a brass tube sliding across the rod, and pressed by a spiral spring to the safety valve *a b* (against which it has been well ground in making it), closing in that situation the openings *i i*.

Such being the construction of the whole, it is evident, that when the elasticity of the steam increases, the two valves, joined together, with the holes *i i* shut, make but one, opposing to the elasticity of the steam an united resistance, which is regulated by the weight *k k*, in the common way; but, on the contrary, when by condensation of the vapours a vacuum is produced, the external air in pressing through *i i*, upon the vacuum valve *g h*, forces it down, and opens to itself a passage into the boiler.

The valve *g h* may easily be made conical, like the other, if that form should be preferred; but in different trials, I have found planes, if well turned and ground together, join as perfectly as can be desired, being pressed by the united elasticity of the spring and the steam.

Fig. 4. is the same contrivance adapted to a new kind of *safety valve* or *piston*, which, though I originally intended it for the use of Papin's digesters of a new construction,* has been, in a larger size, applied by me to steam engines, and is described in the Philosophical Magazine of December, 1803.†

* Nicholson's Journal, March, 1804.

† The description of this contrivance being already published, it would be superfluous to repeat it. I only beg leave to add the following practical remark. A metallic piston, if well turned and fitted into a cylinder of exactly the same kind of metal, will probably have the same degree of expansion, especially if hollow, and consequently will not increase its friction in any increased degree

I have lately begun, and shall pursue, a set of experiments, with the intention of regulating by this safety piston, the quantity of admitted air to fire-grates, and to effect, by that means, a new mode of regulating the fire, and the elasticity of steam in boilers, with less expenditure of fuel and of force than usual; of which idea a hint is given in the work and place above mentioned. The result of these researches I shall at some future period do myself the honour of communicating to that society.

Description of a new Boiler constructed with a view to the saving of Fuel. By BENJAMIN COUNT OF RUMFORD. *Read at a Meeting of the first Class of the National Institute the 6th October*, 1806.

IT is well known that much is gained in the saving of fuel, when an extensive surface is given to that part of the boiler against which the flame strikes, but this advantage is often counterbalanced by great inconveniences. For a boiler of the form usually employed, having the bottom very much extended in proportion to its capacity, must necessarily present a great surface to the atmosphere, and the loss of heat, occasioned by the cold air coming in contact with this surface, may be more than sufficient to compensate the advantage derived from the extended surface of the bottom. And where the boiler is employed for producing steam, as it is indispensably necessary that it should be of a thickness sufficient to resist the ex-

of temperature. But as in practice the cylinder is commonly exposed to a lower temperature than the piston, heated by the steam, a little increase of friction will take place by an increase of heat. To prevent the effect of this, I have found it useful to employ for the piston a metal of somewhat less expansive power than the cylinder: and the expansion of red copper being to that of brass nearly as 10 to 11, I prefer making the piston of the former metal, when the cylinder is made of brass.

pansive force of the steam, it is evident, that if the diameter be augmented (with a view to increase the surface of the bottom) a considerable expence is incurred on account of the additional strength that must be given to the sides.

Having been engaged in the year 1796, in a set of experiments, in which I employed the steam of boiling water as a vehicle of heat; I had a boiler made for this purpose, on a new construction, which answered well, and even beyond my expectations; and, as this boiler might be used with advantage in many cases, even where it is only required to heat liquids in an open boiler, this, and another motive, which it would be useless to mention in this place, have lately induced me to construct one here (at Paris) and to present it to the Insti ute.

The object chiefly had in view in the construction of this boiler, was to give it such a form, that the surface exposed to the fire should be great in comparison with its diameter and capacity; and this without having a great surface exposed to the cold air of the atmosphere.

The body of the boiler is in the shape of a drum. It is a vertical cylinder of copper twelve inches in diameter, and twelve inches high, closed at top and at bottom by circular plates.

In the centre of the upper plate there is a cylindrical neck six inches in diameter, and three inches high, shut at top by a plate of copper three inches in diameter and three lines in thickness, fastened down by screws.

This last plate is pierced by three holes, each about five lines in diameter. The first, which is in the centre of the plate, receives a vertical tube, which conveys water to the boiler from a reservoir which is placed above. This tube, which descends in the inside of the boiler, to within an inch above the circular plate which forms its bottom, has a cock near its lower end. This cock is

alternately opened and shut, by means of a floater which swims on the surface of the water contained in the body of the boiler.

The second of the holes is the plate that closes the neck of the boiler, receives the lower end of another vertical tube, which serves to convey the steam from the boiler to the place where it is to be used.

The third hole is occupied by a safety valve.

This description shews that there is nothing new in the construction or arrangement of the upper part of this boiler. In its lower part there is a contrivance for increasing its surface, which has been found very useful.

The flat circular bottom of the body of the boiler, which as I said before is twelve inches in diameter, being pierced by seven holes, each three inches in diameter, seven cylindrical tubes of thin sheet copper, three inches in diameter, and nine inches long, closed below by circular plates, are fixed in these holes, and firmly rivetted, and then soldered to the flat bottom of the boiler.

On opening the communication between the boiler and its reservoir, the water first fills the seven tubes, and then rises to the cylindrical body of the boiler; but it can never rise above six inches in the body of the boiler, for when it has got to that height, the floater is lifted to the height necessary for shutting the cock that admits the water.

When the height of the water in the boiler is diminished a few lines by the evaporation, the floater descends a little, the cock is again opened, and the water flows in again from the reservoir.

As the seven tubes that descend from the flat bottom of the body of this boiler into the fire place, are surrounded on all sides by the flame, the liquid contained in the boiler is heated, and made to boil in a short time, and with the consumption of a relatively small quantity of

fuel; and when the vertical sides of the body of the boiler, and its upper part are suitably enveloped, in order to prevent the loss of heat by these surfaces, this apparatus may be employed with much advantage in all cases where it is required to boil water for procuring steam.

And as in the case where the boiler is constructed on a great scale, the seven tubes that descend from the bottom of the boiler into the fire may be made of cast iron, whilst the body of the boiler is composed of sheet iron, or sheet copper; it is certain that a boiler of this kind, sufficiently large for a steam engine, a dyeing house, or a spirit distillery, would cost much less than a boiler of the usual form, of equal surface and power.

But in all cases where it is required to produce a great quantity of steam, it will be always preferable to employ several boilers of a middling size, placed beside each other, and heated each by a separate fire, instead of using one large boiler heated by one fire.

I have shewn, in my sixth essay, on the management of fire, and the œconomy of fuel, that beyond a certain limit, there is no advantage derived from augmenting the capacity of a boiler.

It will be perceived, that the boiler which I have the honour of presenting to this society, is of a form fit for being placed in a portative furnace, and it was actually intended for that purpose.

Its furnace, which is made of bricks, with a circular iron grate of six inches in diameter, is built in the inside of a cylinder of sheet iron, seventeen inches in diameter, and three feet high, and can be easily transported from place to place, by two men.

This cylinder of sheet iron, which is divided into two parts, in order to facilitate the construction of the masonry weighs only forty-six pounds. The masonry weighs

about a hundred and fifty pounds, and the boiler twenty-two pounds.

In order to form an estimate of the advantage which the particular form of this boiler gives it in accelerating its heating, we may compare the extent of surface that it presents to the action of the fire, with that of the flat bottom of a common boiler.

The diameter of the bottom of a cylindrical boiler being twelve inches, the surface is 113.88 square inches; but the surface of the sides of the seven tubes that descend from the flat bottom of our boiler (which is likewise twelve inches in diameter) is 593.76 square inches. Therefore, the new boiler has a surface exposed to the direct action of the fire, more than five times greater than that of a boiler of equal diameter, and of the ordinary form: how much this difference must affect the celerity of heating is easy to conceive.

In the manner in which boilers are usually set, their vertical sides are but little struck by the flame, and on that account, I have not taken the effect of the sides into consideration in my estimate; but even taking them into account, the new boiler will always have a surface exposed to the fire, at least twice as great as that of a common cylindrical boiler of the same diameter, as can easily be shewn.

The new boiler being twelve inches in diameter, and twelve inches high, and each of its seven tubes being three inches in diameter, and nine inches high, its surface is 1160.44 square inches, without reckoning the circular plate that closes its top, nor its neck.

The surface of the bottom and sides of a cylindrical boiler of twelve inches in diameter, and twelve inches high, will be 566.68 square inches.

As the quantity of heat that enters a boiler in a given time, is in proportion to the extent of surface that the

boiler presents to the fire, it is evident, that other circumstances being the same, a boiler with tubes descending from its bottom, will be heated at least twice as soon as a cylindrical boiler of the same diameter, with a flat bottom.

In order that a cylindrical boiler with flat bottom, surrounded by flame on all sides, might have the same extent of surface exposed to the fire as a boiler with tubes, it would be necessary to give it a diameter greater than that of the boiler with tubes in the proportion of the square root of 1160.44, to the square root of 566.68, that is, of 17.171 to 12.

Therefore, in order that a cylindrical boiler with a flat bottom, might have the same extent of surface exposed to the fire as our boiler with tubes, of twelve inches in diameter, it would be necessary to give it a diameter of 17.171 inches.

But if the diameter of a boiler intended for producing steam be increased, it is necessary, at the same time, to increase its thickness, in order to increase its strength.

The necessary increase of thickness, and the expence that it will occasion, can be easily calculated.

The effort that an elastic fluid exerts against the sides of the containing vessel, is in proportion to the surface of a longitudinal and central section of the vessel, and consequently in proportion to the square of its diameter, the form remaining the same. Hence we may conclude, that a steam boiler of a cylindrical form with a flat bottom, which has the same extent of surface exposed to the fire as a boiler of twelve inches in diameter with tubes, should be at least twice as thick as this last, in order to have an equal degree of strength for resisting the expansive power of the steam.

The boiler which I have the honour of presenting to the society, is particularly intended to serve as a steam

boiler, but it may undoubtedly be applied to other purposes. Having shewn it to M. Auzilly, son of a considerable soap manufacturer of Marseilles, he thought that it might be employed with advantage in the making of soap; and from what he told me of the process, and of the boilers employed in that art, I am persuaded that the experiment would succeed perfectly.

But after all, it remains to be determined, whether it would not be still more advantageous to employ steam as a vehicle of heat in the making of soap, instead of lighting the fire under the bottom of the vessel in which the soap is made.

The result of an experiment which we are to make, M. Auzilly and myself, will probably throw some light upon this question.—17 *Nicholson's Journal, p.* 5.

The boiler recommended by Count Rumford is by no means a new contrivance. Mr. Stevens obtained a patent in 1805 (the specification of which may be seen in the Repertory of Arts, Vol. vii. p. 173.) for a boiler formed in a similar manner, by a number of tubes placed parallel to each other, and communicating with a flat vessel at one of their extremities; the number of the tubes to be used was not defined by Mr. Stevens, and the capacity of the vessel that received the ends was much less than that here described, and though this must occasion some difference of external appearance, the principle is undoubtedly the same in both.

There is no account of comparative experiments made with this new boiler and others, to enable us to decide on its merit. But as far as can be judged from a knowledge of various other experiments on boilers, we cannot have any good expectations of this form for boilers. The great additional workmanship necessary for it, must add considerably to the expence; and the very remark which the

Count makes on the advantage of numerous small boilers, with each a *separate* fire-place, shews that he was at least doubtful in recommending the use of this on a large scale.

The Count has made a considerable mistake in asserting that an equal surface will have more strength to resist internal pressure in a boiler of the shape proposed than in one of the common form; the sum of the pressure in all boilers, with the same force of steam, is demonstrably as their internal surfaces, and the only difference the form makes, is, that globular forms are least liable to have their shape altered by the pressure, flat forms most, and the intermediate shapes more or less so, as they most resemble the flat or globular form.

A variety of plans have been tried to make the same quantity of fuel produce greater effects by some particular formation of the boiler; among these, none seem superior to that for which Mr. Edmond Lloyd, in the Strand, obtained a patent, in simplicity or effect; the principle has hitherto been used chiefly for kettles, and other small vessels made for sale by Mr. Lloyd; but there is no cause why it should not do equally well for large boilers; and there is reason to think that they would be much preferable to the Count's new boiler, and would certainly cost much less.

One of the kettles of this form will boil two quarts of water in less than ten minutes, with less than a third of one of the common penny bundles of fire-wood, sold every where in London. As a description of the principle on which they are made may be acceptable, the following account of it is presented to our readers, to most of whom, we believe, it will be novel.

Description of Mr. Lloyd's Patent Boiler for quick boiling and saving fuel.

The bottom of each of Mr. Lloyd's boilers is introverted, so as to form a cavity which would nearly hold as much as the boiler itself, if it were reversed; the sides of this cavity are somewhat conoidal, and from the top a pipe passes out at one side through the cavity of the boiler to the air; the whole boiler or kettle, is surrounded by an external case, a little distant from it all round, closed at top, and having a small opening at the side to give vent to the smoke. The small pipe adds somewhat to the effect, but is not absolutely necessary. For large boilers the cavity at the bottom need not be so large in proportion as that described, if it rises into the boiler a third of its depth, it will probably be sufficient. The flame and radiant heat of the fuel is reverberated in all directions in the cavity of the hollow bottom, and must have much more effect than what can be produced by its unconfined lateral action against the external sides of a number of upright pipes however well arranged; indeed Count Rumford has shewn in former papers, the value of the lateral action of fire against the sides to be so small, that we are surprized to see him recommend the apparatus above described, in which the chief effect produced must arise solely from a similar lateral action of the fire.

Account of a successful expriment in making soap by the operation of steam, instead of an open fire, communicated by Count Rumford to the French National Institute. Phil. Journ. No. 71.

The steam was conveyed into the vessel, which contained the ley and other materials for the soap, by a pipe arising from a close boiler, and again descending into the vessel; the action of the steam in condensing in the cold ley, occasioned a succession of smart shocks, similar to

blows of a hammer, which caused the whole apparatus to tremble, but which gradually subsided as the liquid became warm. Count Rumford supposes, that the beneficial action of the steam depends for the most part on the motion described, caused by it, and therefore proposes dividing the vessel into two parts by an horizontal partition of thin copper, and causing a slow current of cold water to pass through the lower division, and to let the steam into this lower part, when the upper became too hot to admit of a continuation of the strokes from the condensation of the steam; by which means the same motion being continued in the cold water, would be communicated to the hot liquid through the thin partition.

The soap made by the operation of the steam, required only six hours boiling, whereas sixty hours and more are necessary in the ordinary method of making soap. 2 *Athenæum* 66.

Familiar account of the method of estimating the value of a Steam Engine in horse-powers as they are called. By a correspondent.

To Mr. NICHOLSON.

Sir,

AS your excellent journal is the repository for useful information, whether scientific or practical, I have thought I should oblige many manufacturers and others of your readers, by sending you a very clear report about horse-powers, which a friend of mine has communicated to me, and was received by him from an eminent character in answer to an enquiry professionally made.

It clearly appears from this paper, that the calculation by horse-powers must be fallacious, unless engineers could agree as to the quantity of work they would arbitrarily, in the first instance, ascribe to one horse; and then the expression would be nugatory. And not only so, but it would not then be true that the value of a steam

engine in work, however clearly expressed in quantity *per* day, would be fairly shewn, unless the wages or food of the working being were taken into the account. Coals may be stiled the food of a steam engine, and nothing is more evident than that, if two engines raise equal quantities of water *per* hour, but consume different quantities of coal, they will not be equally beneficial to the proprietors. I would therefore propose, that the estimate should be made by attending to these two particulars only, and saying nothing about horses, at least in specific arguments intended to have legal effects: And, as a supplement to the facts and observations contained in the report, I will add, that one of the best engines of Boulton and Watt, has been known to raise between 28 and 30 millions of pounds of water to the height of one foot with one bushel of good coals, which appears to be an outside measure; and that, though there are subsequent improvements both in the construction of furnaces and the working gear, yet there are some among late engines which fall short of 20 millions.

I am, Sir,

Your constant reader,

E. T.

*Report concerning the power of a Steam Engine erected by contract at * * * *.*

IT is required to determine whether the steam engine erected at * * * * by Mr. ——, be equal to the power of sixteen horses. The same has a cylinder of $21\frac{1}{8}$ inches diameter, and gives 23 double strokes *per* minute, of four feet each.

In answer to this question it must be previously remarked, that steam engines having originally been recommended and substituted instead of horses, the method of computing by the number of those animals intended to be supplied by means of this invention, has been general-

ly applied, though it is much less certain and accurate than other methods well known to mechanical men. The uncertainty of calculating by horse-powers arises from various causes; such as the great differences of ability between the strong and heavy horses used in London, and those of not half the strength used in various parts of the country; the greater or less degree of speed during work; the quantity of re-action against which they are urged to pull; the shorter or longer time of work; their food, stabling, &c. &c. And this uncertainty, as may easily be conceived, is so great, that the words *horse-power* cannot practically be applied, otherwise than to denote a certain quantity of mechanic effect agreed upon and understood between engineers, and must not be understood to denote any elementary measure, capable of being worked out or inferred within any reasonable or useful limits, from the real power of the horse himself.

It therefore follows of necessity, that the engine must be examined by first stating its mechanic effect; that is to say, how many pounds weight it is capable of raising through a given space in a given time, that is to say, through the height of one foot during one minute, and then dividing this sum by the like effect producible by one horse, according to the statements and practice of engineers of the first reputation. I confine myself to Messrs. Boulton and Watt, Dr. Desaguliers and Mr. Smeaton.

The practice of Messrs. Boulton and Watt is, to consider a horse as capable of raising a certain weight, which is stated to be of 3.,000 pounds avoirdupois, one foot high in one minute. Desaguliers' results brought to the same form, give 27,500 pounds; and Smeaton's 22,916 pounds, under the same circumstances. The lowest of these performances are more than equal to the average power of a horse employed in husbandry for eight hours *per* day.

If the diameter of the cylinder be multiplied by itself

(21 1-8 × 21 1-8), the product will give 446 1-4 round inches for the whole surface: and Smeaton reckons the effective or working pressure *per* round inch on the atmospheric engine, at seven pounds avoirdupois. It is usual to reckon the working pressure on a close engine (like that in question), at 10 pounds the round inch; but I shall first take the seven pounds as being against the builder: So that, by multiplying the round inches 446 1-4 by 7, we have 3123 3-4 pounds for the weight raised. But the strokes are 23 of four feet double *per* minute, that is to say, 184 feet. Multiply the weight 3123 3-4 by the height 184, and the product 574760 will be the mechanic effect of the engine, or the number of pounds it will raise one foot high in one minute. Lastly, divide this by Boulton and Watt's horse-power ($\frac{574760}{32000}$), and the quotient $17\frac{15}{16}$, or very nearly 18, will express the power of the engine in horses.

If we follow Desaguliers, the engine will prove equal to 21 horses.

And, according to Smeaton, its power will be equal to 25 horses.

If we had taken the pressure at 10 pounds *per* round inch, the powers would have proved much greater, as below.

In the above calculations the horses are supposed to be fairly worked, and the engine is supposed to be stopped as soon as the horses leave off. But an engine can work the whole 24 hours; and Smeaton, considering that three setts of horses must be kept to work constantly for the same time, reckoned a steam engine to be equivalent to three times as many horses as could equal its rate of working. The following table will shew the powers of this engine, according to all these several methods:

	Power in horses according to Boulton and Watt.	Do. according to Desaguliers.	Do according to Smeaton.	24 hours work according to Smeaton in horses.
7lb. pressure per round inch.	$17\frac{96}{100}$ or 18 very nearly	21	25	75
10lb. pressure per round inch.	25	30	$35\frac{3}{4}$	107

9 *Nich. Journ.* 214.

Remarks on the estimation of the Strength of Horses. In a letter from Mr. O. GREGORY, *of the Royal Military Academy, Woolwich.*

To Mr. NICHOLSON.

SIR,

The remarks of your ingenious correspondent, Mr. Hornblower, on the various estimates of the *Power of a Horse*, and the absurdity of adopting a quantity so fluctuating and so difficult to ascertain, as a common measure by which the powers and effects of steam engines and other machines are to be estimated and compared, have induced me to throw together a few observations on the same subjects; the theoretic part of which, though familiar to most men of science, seems not to be always known, or at least recollected, by some persons who are employed in the practice; and which are altogether much at your service for insertion in the Journal, if you think them likely to be of any utility.

Dr. Desaguliers has given another estimate of the labour of a horse, beside that mentioned by Mr. Hornblower, and which indeed does not seem very consistent with it; for in vol. II. p. 251. of his Experimental Philosophy, he affirms that a horse in an advantageous situation, is able to draw 200lbs. eight hours a day, walking at the rate of 2 1-2 miles in an hour, or 3 2-3 feet in a second. This statement of the power of a horse, though it is not so great as that which is arbitrarily assu-

med by Messrs. Boulton and Watt, exceeds the determination of M. Sauveur, who estimates the mean effort of a horse at 175 French, or 189 avoirdupois lbs. with a velocity of rather more than three feet per second ; and it probably exceeds Mr. Smeaton's statement of 550lbs. moved 40 feet in a minute ; though, as will soon be seen, we are not furnished with proper data to institute a comparison between these various results. It is probable, however, as observed by the ingenious contributor of the article at page 216, vol. IX. of your Journal, that "the lowest of these performances is more than equal to "the average power of a horse employed in husbandry "for eight hours per day." So far as my own observations on this point extend, I am inclined to conclude that the average work of a stout London cart horse, for eight hours in a day, is little if any more than 130lbs. moved at the rate of three feet in a second, or 2 1-22 miles *per* hour. But this it would be ridiculous to assume positively as a universal unit of measure, in a case where the causes of variety are so numerous, and my opportunities of experiment comparatively few. The estimate just given, it should be observed, is not intended to express what a horse can draw upon a wheel carriage, where friction alone is to be overcome, after the load is once put into motion, and where a horse will often draw much more than 1000lbs. but the weight which a horse would raise out of a well, &c. the animal acting by a horizontal line of traction turned into the vertical direction by a simple pully or roller, whose friction is reduced as much as possible.*

Before we can institute any comparison between the

* The late Mr. More, Sec. to the Society of Arts, found by the interposition of a graduated spring instrument between the horse and his work, that the re-action was between 70 and 80lb. when the velocity was three miles in an hour. I think the work was ploughing. See Philos. Journal, quarto, vol. III. 136. N.

results of different experiments, it will always be necessary to enquire what machine was interposed between the weight moved and the animal, in each case, that we may thence deduce the real velocity with which the animal moved, from the velocity of the weight or load given by the observations. This is too frequently omitted in consequence of an implicit reliance upon a maxim, which, though highly useful under proper restrictions, is far from universal in its application. In the case before us, if we admit the maxim now alluded to, namely, that *what is gained in power is lost in time*, with regard to the machine through whose intervention the velocity of the weight is rendered different from that of the horse, it would be unsafe to adopt it in the appreciation of the varied energy of the animal when moving with different velocities. The reason of this is obvious. The energy of the horse is obliged to be employed not only in overcoming the weight or resistance which opposes his progress, but in part in moving *himself;* for the particles which constitute his frame possess weight and inertia, and therefore cannot be put into motion without effort. Hence it follows that there is a certain velocity, which may be denoted by U, with which, when the animal moves, his whole power will be employed in producing his own motion solely, without being able to move any other body. If a body whose mass is M be attached to the horse, so that he cannot move without giving an equal velocity to the extraneous body, the same effort being employed both in moving the animal and the mass attached; the velocity V, with which they move must necessarily be less. And if M be farther increased while the weight and energy of the horse continue the same, the velocity V will be still farther diminished; and thus as M increases V will diminish, until when M arrives at a certain magnitude, W, the animal is unable to make any progressive motion, and exerts his force at what is

called a dead pull. If M exceeds W, then will V become negative, and instead of the animal advancing with the load, the load will compel him to move backwards and no useful work can be accomplished.

Now these circumstances may be expressed algebraically, by the general formula $M \propto (U-V)^n$, in which the exponent n can only be determined by means of judicious and numerous experiments, where the magnitude of M should be ascertained for many variable values of V between the terms V=U, and V=o. From this theorem, following the common rules for the maxima and minima of quantities, it may readily be found that in order to have the *useful* work done the greatest possible, we we must increase or decrease the weight till V becomes $=\frac{U}{n+1}$, when the performance will be denoted by $\frac{n^n}{(n+1)^{n+1}} \times WU$ And if the value of V thus exhibited be once ascertained experimentally, we need never be apprehensive of a material loss by a small variation from it; for by a well known property of those quantities which admit of a proper maximum and minimum, a value assumed at a moderate distance from either of these extremes will produce no sensible change in the effect.

In some of the actions of men, such as dragging a boat along a canal, &c. the value of n in the preceding theorems has been found to be nearly =2. And the draught of horses is conformable to a law not widely different. The best experiments which have yet been made on this point with regard to horses drawing in nearly rectilinear paths, lead us to conclude that n is then very nearly $=\frac{9}{4}$, in the expression $M \propto (U-V)^n$. Assuming therefore, for the utmost walking velocity of a horse, the value

U=9 feet per second, a value which is quite high enough, any proposed estimates of the strength of this animal may be compared with facility. Thus, for example, let us enquire which is greater, the estimate of Mr. More (mentioned by Mr. Hornblower) of 80lbs, three miles per hour, or $4\frac{2}{3}$ feet per second; or that of 130lbs. moved at the rate of three feet per second? Here we shall have

$$(9-3)^{\frac{9}{4}} : (9-4{\cdot}4)^{\frac{9}{4}} : : 130 : 71\frac{1}{2}\text{lbs. nearly.}$$

The operation may easily be performed by means of a table of logarithms, and shews that the mean estimate I have laid down, when reduced to the same velocity as that by Mr. More, furnishes a result less than his by $8\frac{1}{2}$lbs. Which of these is the most accurate can only be determined by future experiments.

If, however, either of these estimates should be adopted, it may be proper to remark that they would not hold with regard to the power of horses working in circular paths; yet, if it be at all proper to use *horse-powers* in estimating the energy of machines, it seems most natural to take these powers as exerted by the animal in a round walk; so that it is still necessary to have a series of experiments to determine the values of n, and the relation of M and V when horses draw in circular walks of different radii. I say, of *different* radii, because it is certain that *cæteris paribus*, the greater the radius of the circle in whose circumference the animal moves, the less fatigue will be occasioned by that kind of motion. Indeed it is obvious, that since a rectilinear motion is the most easy and natural for the horse, the less the line in which he moves is curved, with the greater facility he will walk over it, and the less he need recline from the vertical position. Besides this, with equal velocity at the circumference, the centrifugal force will be less in the greater circle, which will proportionally diminish the friction of the cylindrical part of the trunnions, and the labour of

moving the machine. And farther, the greater the radius of the horse-walk, the nearer the chord of the circle in which the horse draws is to coincidence with the tangent, which is the most advantageous position of the line of traction. Hence it follows, that although a horse *may* draw in a walk of 18 feet diameter, yet he will work with far greater ease in one whose diameter is 35 or 40 feet; and it is very desirable that an experimental enquiry should be made to ascertain the proportion and absolute quantity of work in different circles.

I am of opinion that it would not be difficult to make some useful experiments, while work was actually carrying on at any horse mill, or machine where horses are constrained to move in a circular walk. The simple drawing which accompanies this letter will assist in conveying a clear idea of the method which I fancy might be advantageously adopted. Let AB *Fig.* 1. *Plate* IV. be the vertical shaft to which the horizontal horse-poles AC, AD, are attached. Let one horse work the machine by drawing at the ear E; but, instead of the transverse bar to which the harness is fixed being simply hung upon the hook *h*, let a good spring steelyard be interposed between that cross-bar and the hook, the graduations of which shall, when the machinery is put into motion, indicate the resistance (in lbs.) overcome by the animal, including the weight of the mass moved, the friction, &c. Near the extremity of the opposite horse-pole AD, let there be fixed a strong and correct common steelyard, whose divisions shall shew the various weights from 40 or 50 to 200lbs. and whose centre of motion shall be at the point *f* on the fixed stand. Let the cord *c* which is fastened to the shorter arm of this steelyard, pass (with as little friction as possible) over the pulley *p*, and thus, being turned into the horizontal direction, or rather, inclining a little upwards, let it be fixed to the cross bar of the har-

ness of a second horse, equal in point of strength to the former. Then if the two horses, thus attached to the ears E and F, be made to pass over the walk in the same direction, following each other constantly at the distance of a semi-circumference: while that which draws at the ear E overcomes the whole pressure and resistance opposed by the work, the other which draws at F by the cord over the pulley *p*, will raise the weight *w* of the steelyard; which therefore, by being moved to and fro upon the arm *f i*, may be brought to exhibit an exact counterpoise, or measure of the exertion and power of the horse. And in order to ensure the greatest degree of accuracy in this respect, the motion of the two animals, and the position of the weight *w*, should be so adjusted, that the same weight should be shewn by the graduations both of the spring and of the lever steelyard. The shaking of the machinery will in some measure disturb the effect; but an ingenious manager of the experiments will find means of checking this: and as to the centrifugal force to which the weight *w* is exposed, it will never be of any material consequence in any of the slow motions which will be produced by this kind of work.

Each experiment should occupy the space of a fair day's work for the horses: for the conclusions deduced from shorter and irregular efforts are always erroneous in excess, and should be guarded against. The rate at which the animals move may readily be ascertained from the known circumference of the walk, and the number of rounds they are observed to make in 10 or 15 minutes. Thus, by continuing the experiments day after day, varying the velocity of the motion in some cases, and the radius of walk in others, such a series of results might at length be obtained, as would in a great measure remove the obscurity and doubt in which this business is at present enveloped. It is scarcely necessary to suggest the

propriety of making a few experiments with a view of determining how far a load upon the back of each draught horse, would assist him in his labour. Nor can it be requisite to point out in what way, by means of such steelyards properly applied to waggons, &c. upon tolerably smooth roads, and two horses marching abreast, (one drawing the load, the other raising the weight,) experiments might be instituted to ascertain the magnitude of the efforts of horses when drawing in rectilinear paths. Judicious experiments having these purposes in view, would certainly be beneficial, as they would enable us to tell what advantages might be expected from the labours of this useful quadruped in different circumstances. But with respect to the adoption of "*horse-power*" as a unit of force in estimating the power of steam engines, &c. I confess that if it were as well known, and as unvariable as the length of the day of the equator, I should feel an aversion to applying it to any such purpose. It is a common measure arbitrarily adopted, which has no necessary connection with the subject that is referred to it, which does not in any respect facilitate the computation of the powers of an engine, and which may, without proper caution, lead to considerable errors in the conclusions deduced from it.

Before I close this letter, already perhaps too long, I beg permission to say a few words respecting the measure which is generally employed to determine the mechanical effect produced. This is the measure of the deservedly celebrated Mr. John Smeaton, who says that "the weight of a body multiplied by the height through which it descends, while driving a machine, is the only proper measure of the power expended; and that the weight multiplied by the height through which it is uniformly raised is the only proper measure of the effect produced." Mr. Smeaton was led to the use of this

measure by his professional habits; and many who in this respect pay too great a deference to his authority, have adopted this measure as universal and preferable to any other. Taking this as a popular measure easy to recollect, and simple in its application, it undoubtedly has its uses; but in many instances it is inadequate to the purpose for which it is proposed. The late Professor Robison has some excellent observations on this subject, in the article *Machinery*, *Sup. Encyclopædia Britan.* where he lays down the just measure to which the scientific investigator will generally have recourse. "We take, says he, for the measure, (as it is the effect) of exerted mechanical power, the quantity of motion which it produces (or whose accumulation it prevents) by its uniform exertion during some given time. We say *uniform exertion*, not because this uniformity is necessary, but only because, if any variation of the exertion has taken place, it must be known in order to judge of the power."

A single instance may be adduced, to which the measure of Mr. Smeaton is inapplicable, and in which we must have recourse to some such measure as that mentioned by Professor Robison. Suppose that a horse while standing still sustains by means of a rope and simple fixed pulley, a mass of a hundred weight, and thus keeps it suspended at the top of a well, for the space of a minute. Neither the animal nor the weight moves, but shall we therefore say, in conformity, as it would seem, with Mr. Smeaton's measure, that there is no power expended, and no effect produced? On the contrary we know there *is* a power expended, and that the effort if sufficiently long continued would completely tire the horse. The effect which is produced is the annihilation of the simultaneous action of gravity upon the suspended mass; consequently, the effect produced is equal, and contrary to the momentum that would be generated by gravity in the

space of a minute. So that $50 \times 32\frac{1}{6} \times 112 = 216160$, is the proper representative of the power expended, as well as of the work done. Were the rope to be cut and the weight suffered to fall for a minute, the same number would likewise denote the labour of the horse in restoring it to its original place, provided that could be accomplished in an equal space of time, without the horse changing his situation.

It may not, perhaps, be entirely useless to state this matter rather more universally. To this end, let M represent any mass or body, $g = 32\frac{1}{6}$ feet, the velocity communicated to a body falling freely in the first second of time, and t' an indefinitely small portion of any time whatever t. Then will $g\,t'$ be the velocity generated in the instant t', and $M\,g\,t'$ the corresponding quantity of motion; this, therefore, measures the effort which must be exerted at each instant to sustain the weight, whether that effort be applied immediately, or through the intervention of a single fixed pulley. Hence it follows, that during the whole time t, the force will have consumed a quantity of motion equal to $s\,M\,g\,t' = M\,g\,t$: that is to say, if t denote the time at the end of which the agent is no longer able to sustain the mass M, we may regard $M\,g\,t$ as being an adequate measure of the force Q of that agent. If the agent not only prevent the mass from falling, but actually raise it with a given uniform velocity V during the whole time t, then we must add the quantity of motion MV to the former, which gives $Q = MV \times M\,g\,t = M\,(V \times g\,t.)$ And lastly, if the agent possess inertia, its mass must also be considered. Thus, in the case of a horse whose mass is H, moving along with the velocity V during the time t, and raising the mass M, we shall have $Q = (M \times H)\,V \times M\,g\,t$. And from similar principles formulæ may be investigated to represent the power of a first mover in more complicated cases.

It will after all, be proper to distinguish carefully between the quantity of power expended, and that portion of it which is *usefully* employed: but a due consideration of this would too widely extend the limits of the present communication. Indeed I ought to apologize to yourself, and the scientific part of your readers, for dwelling so long as I have done upon topics which are well known to all who are conversant in the theory of mechanics: but if those, for whose use this letter is chiefly intended, shall derive some precise information, or add to the stock of their practical knowledge, by any hints of mine, I shall not fear being heavily censured for having entered thus into minutiæ.

I am, Sir,

Your's very respectfully,

OLINTHUS GREGORY.

Royal Mil. Academy, Woolwich,
June 10*th*, 1805.

(11 *Nicholson's Journal*, *p.* 145.)

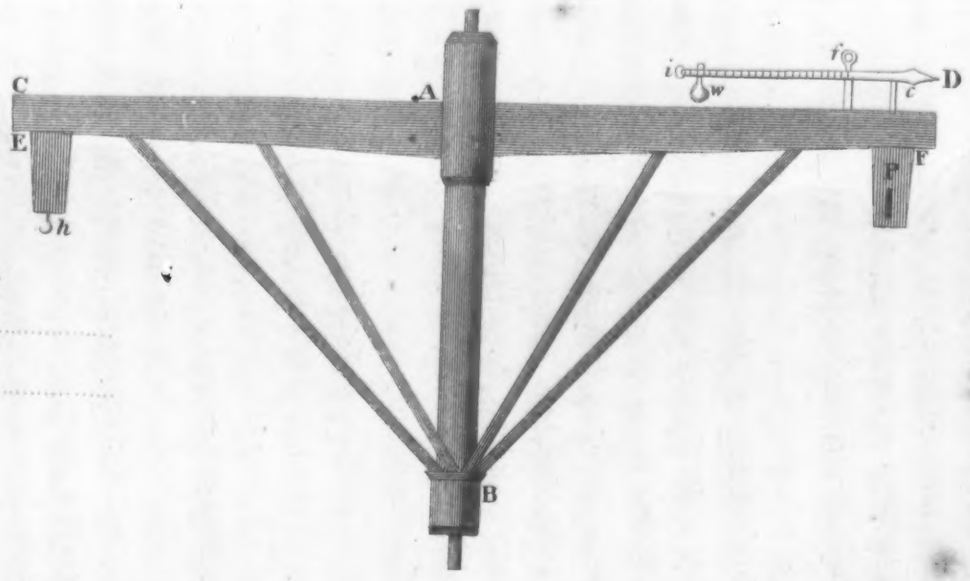
On the Construction of the Beams of Steam Engines. By Mr. J. C. HORNBLOWER. *From the Author.*

DEAR SIR,

I BEG leave through the means of your Journal, to lay before the public an account of the framed lever mentioned at the close of the article *Carpentry* in the supplement to the Enclycopedia Britannica, as it was originally designed for an engine to have been erected at Amsterdam in the year 1776, together with two others, possessing every possible advantage of levers consisting of small scantles.

I know not by what means the lever above referred to come to be constructed with the disadvantages intimated by the writer of that article, but there is no necessity for a hole to be bored, or a bolt to be driven in any part of the framing between the arches, except for the chain stays.

Mr Gregory's contrivance to determine Horse power in Mills.



Mr Woolf's rotatory apparatus.

See page 384.

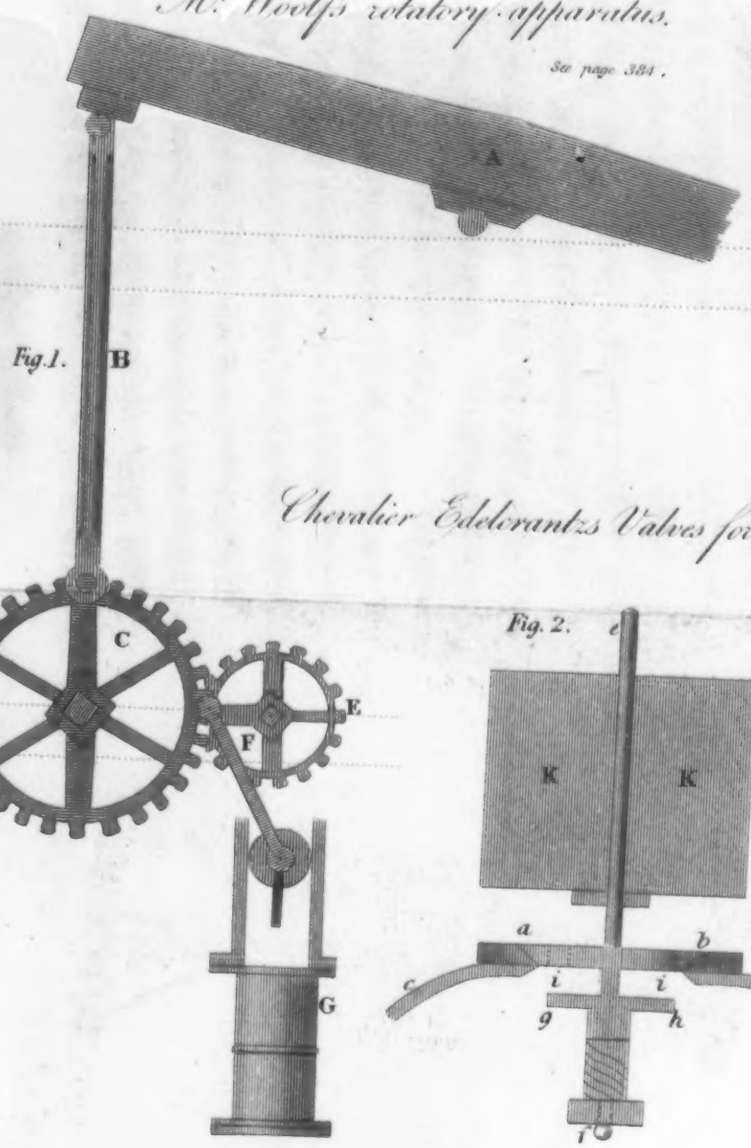


Fig. 1.

Chevalier Edelcrantz's Valves for Steam Engines.

Fig. 2.

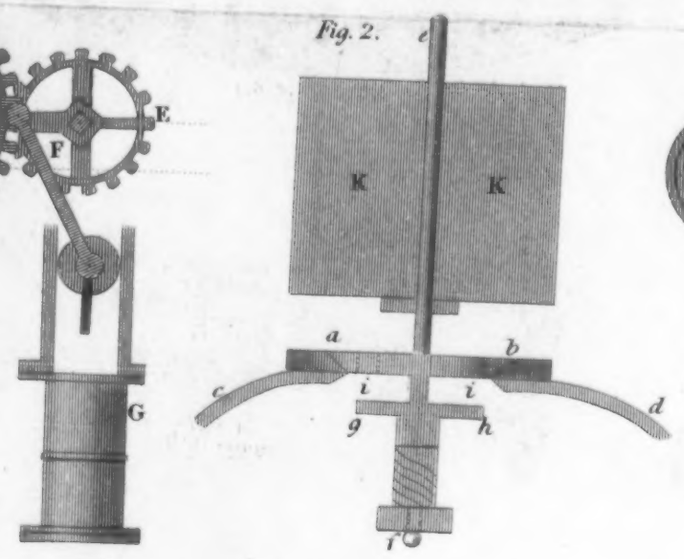
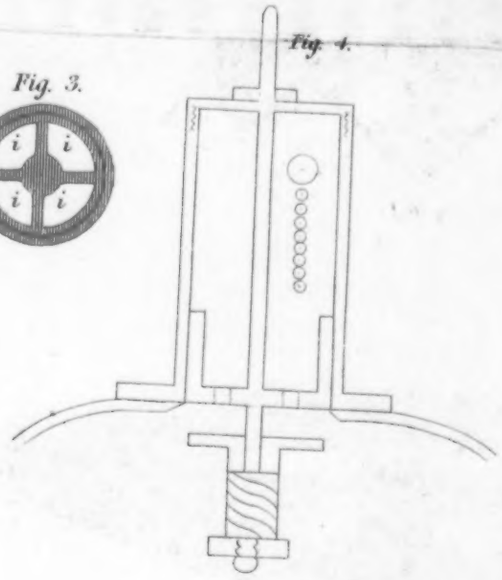


Fig. 3.

Fig. 4.



Strong framed Levers for steam Engines by Mr Hornblower & others.

Iron Cradle.
Fig. 1.

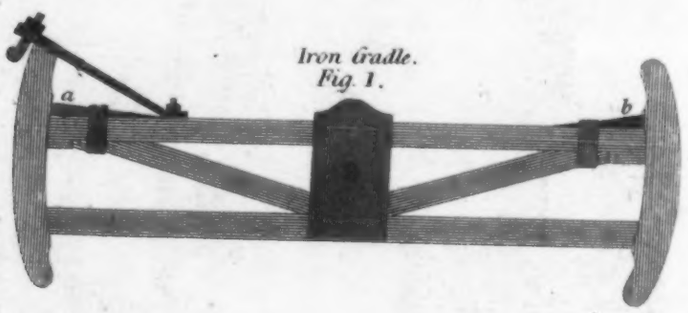


Fig. 2.

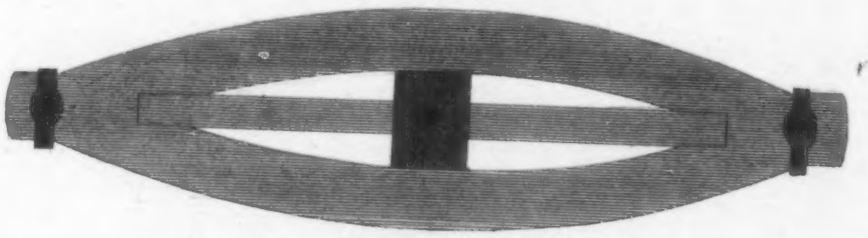


Fig. 3.

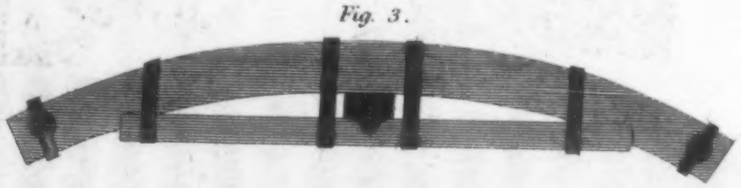
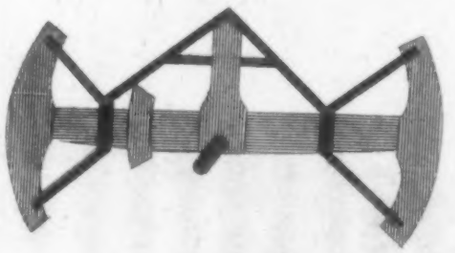


Fig. 4.



Tiebout. Sc.

The wedges *a*, *b*, Fig. 1. Plate IV. thus applied, would be an improvement, for want of which a lever of this sort in the hands of a negligent engineman had one of its joggles forced off, the shoulder of the tennon, which was morticed into the arch, not being a joint by the eighth of an inch, or more; but when it met with the arch it went no further, and continued to work for many years under a great load, and much to its disadvantage in other respects.

The length of this lever was 21 feet, the scantles were 12 inches by 6; height of the whole when put together 30 inches, and leverage on the gudgeon as 4 to 3. This last circumstance operated much against its construction, by giving additional force against the joggle at that end, but had it been framed six inches higher, I doubt not but it would have stood to this day under all its disadvantages.

The sum of the scantles is 18 by 12, area of the section 216 inches, column of water in four lifts 4800 lbs. with 440 fathoms of rods, (pump rods) which with the appendages on the other end, added to the power necessary to overcome the resistance, amount to about seven tons.

But a much simpler, and in some respects a more advantageous mode of framing is shewn at Fig. 2, and may be constructed with or without arches. This, with little variation, is the invention of a Dutch gentleman, and was applied to the load of a 52 inch cylinder (an atmospherical engine) set up with advantages, which in point of workmanship at that time was perhaps not equalled, and therefore may be said to have been fairly tried.

This engine was calculated to raise 60,000 gallons per minute, and the scantles were 18 by 12, and 12 by 8, and where such timber can be had, it is hardly to be expected to have a lever with greater advantages than this for a single stroke, and where a double stroke is required it may be doubled for that purpose, retaining all its princi-

ples and properties as in Fig. 3. which I suppose needs no explanation.

Fig. 4. is a lever constructed by an eminent engineer in Hungary some years since, which possesses a very great degree of support by the king post and iron braces, but does not, in my opinion, discover so much science as the two preceding ones. I forgot to observe, that inner arches may be attached to Fig. 1. without materially affecting its principle, if they are well let on the whole framing, and bolted to each other without passing through the scantles.

I am, Sir,

Your most obedient Servant,

J. C. HORNBLOWER.

East Row, City Road, Tuesday, May 11, 1802.

(2 Nich. Journ. 68.*)*

Letter from Davies Giddy, *Esq. M. P. describing a singular fact of the invisible emission of steam and smoke together from the chimney of a furnace; though either of them, if separately emitted, is visible as usual.*

To Mr. NICHOLSON.

SIR, *Clifton, August* 6, 1805.

TRAVELLING, and a variety of occupations, have hitherto prevented me from sending you an account of the circumstances observed by myself and others, during the working of an engine on Mr. Trevethick's construction, at Merthyn Tidwell in South Wales, and which I had the pleasure of relating to you, some time since, in Soho Square. I now transmit a statement of the facts, avoiding all comments or attempts at explanation.

Mr. Trevethick *having adapted his steam engine to the purpose of moving waggons*, contrived every accessary part as light as he possibly could, and as little inconvenient to persons who might assist, or witness an experiment. The flue for conveying off the smoke, and afford-

ing a draft, was made of rolled iron; and the steam, which wholly escapes from these machines uncondensed, was conducted into the same tube, about a foot above its insertion into the boiler; therefore many feet from the fire, and beyond the register. When the engine began to move, it was soon remarked that neither steam nor smoke were seen to issue from the flue: and when fresh coal was added, nothing more than a faint white cloud became apparent, and that only for a short time; nor were drops or mist visible any where. It was proposed, that the register should be slowly closed; and as this was done, a condensation of steam manifested itself at a small distance from the chimney, and finally appeared in the same quantity, as if it had proceeded immediately from the boiler. The experiment was then reversed. The steam was gradually confined to the boiler; when smoke became more and more visible, till it equalled in quantity and appearance that commonly produced by a similar fire: and these trials were alternated a great number of times, with unvarying success. Lastly, it became a matter of speculation, whether or in what degree the draft was affected by the admission of steam into the flue. To ascertain this, every one present looked as attentively as possible into the fire-place; while the en gine moved at the rate of a few strokes in a minute; and all agreed in declaring, that the fire brightened each time the steam obtained admission into the chimney, as the engine made its stroke.

I am, Sir,

Your very faithful humble servant,

DAVIES GIDDY.

(12 *Nicholson's Journal, p.* 1.)

Description of an Engine for affording mechanical power from air expanded by heat; by Sir George Cayley, *Bart.**

To Mr. NICHOLSON.

SIR, *Brompton, Sept.* 25, 1807.

I OBSERVED in your last vol. p. 368, that some experiments have been lately made in France upon air, expanded by heat, applied as a first mover for mechanical purposes. This idea, as you justly remark, is by no means new in this country; yet I have not heard that any successful experiments have been made, exclusively upon this principle, in England, though you hint that something promising has been accomplished relative to it.

The subject is of much importance, as the steam engine has hitherto proved too weighty and cumbrous for most purposes of locomotion; whereas the expansion of air seems calculated to supply a mover free from these defects. Under this impression I send you a sketch of an engine I projected upon this principle several years ago; it was made on a considerable scale at Newcastle, though I must confess without success in the result, which I attributed to the imperfect manner in which it was executed, the cylinders being made of sheet copper, and so irregular, as not to be rendered tolerably air tight by any packing of the piston. I think there can be no doubt that the scheme is practicable in some way or other; and I conceive that the form of the engine here sketched will be the basis of whatever experience may prove to be additional requisite to perfection in the apparatus of the air engine.

A and B, Plate 8 fig. 1, are two cylinders, placed one

* I extract this paper merely to give notice of the idea expressed in it. I do not think it necessary to give the plates of a machine that has not succeeded. T. C.

above another; C and D, their respective pistons connected by one rod. F is a cylinder, containing a fire in a vessel within it in such a manner, that any air passing between the upper and lower portions of it must go through the fire. This vessel also contains a long cylinder, open at the bottom and directly over the centre of the fire, for the purpose of holding coke or other fuel. This cylinder is covered at the top, and packed air tight when it has served the purpose of permitting the fire to be kindled through it: and has been filled with fuel.

The cylinder B is fitted up to answer the purpose of a double stroke forcing pump, or bellows, to drive the air into the upper portion of the vessel F, from whence it passes *downwards* through the fire for the purpose of consuming the smoke (the fresh fuel being supplied from the reservoir above) in its passage through the more completely ignited cinders below. In this act the air is expanded; and, by means of pipes from the lower portion of F, it is conveyed alternately above and below the piston of the cylinder A. In each pipe is fixed a stop cock or valve, so constructed as to open a passage to the external air, when it shuts the connection with the fire vessel. These cocks are worked by a plug frame.

From this construction it will appear evident, that whatever expansion the air receives, its pressure will operate alike upon the piston of the bellows and of the receiver; and that always in opposition to each other: Hence the power of the stroke will be in proportion to the excess of the area of the receiving piston, over that of the feeding one, multiplied by the expansive force of the contained air, and by the length of the movement.

If, when the engine is well constructed, the expansion of the air in keeping up the fire be not found sufficiently sensible, still the form of the engine is such as to admit of either inflammable gas, oil of tar, or other inflammable

matters, being injected, each stroke, upon the fire; so that all the heat generated by the united combustion may operate without waste; perhaps even a slight sprinkling of water, either upon, or round the sides of the fire, might answer the purpose. It scarcely need be observed, that a tube connected with a small forcing pump are the only things required for producing these effects.

I remain, Sir,

Your obedient servant,

GEORGE CAYLEY.

(18 *Nicholson's Journal, p.* 260.)

Summary of the rise and progress of the STEAM ENGINE. *By the Editor.*—I have now given all the information I deem important, on the *iron manufacture*, and the *steam engine*. The references I have furnished, will enable the reader to supply the slight deficiencies of information, as they comprise every publication of any character upon the subjects discussed. The summary of the improvements gradually introduced in the theory and practice of the steam engine, and inserted in No. 2 of this volume, p. 217, was printed during my absence in Philadelphia; and unless the errata be corrected, will not in some places be intelligible: for this reason, I chuse to repeat that summary, with a few additional remarks.

1. It does not appear that the theory of the steam engine was ever clearly suggested until the Marquis of Worcester's Century of Inventions in 1663. An old historian, I do not know who, writes concerning Pope Silvester (Silvester 2d) thus: Fecit arte mechanica, orologium, et organa hydraulica, ubi, mirum in modum, per aquæ calefactæ violentiam, implet ventus emergens concavitatem barbati, et permulti foratiles tractus æreæ fistulæ modulatos clamores emittunt. 1 Athenæum, 136. I wish

the compiler had cited, by name, the author of this account: this mode of blind reference is a very silly practice.

2. The first person who appears to have reduced the theory of the Steam Engine to actual practice, was Capt. *Savary*, about 1696. He made a vacuum in a pipe whose lower end descended into water, by condensing steam thrown into a reservoir connected with the pipe; and this permitted the atmosphere to press the water upward to the usual height that will counteract or sustain the atmospheric column: he then forced it upward by the pressure of Steam upon the surface of the water in his receiver, or reservoir.

3. *Newcomen* and *Crawley*, in 1712, erected an engine wherein the piston working in a cylinder, was raised upward by the force of Steam; which being condensed by injecting water into the cylinder, a vacuum was formed, and the piston was depressed by the weight of the atmosphere on the top of it, no longer counteracted by the atmosphere underneath it.

In *Savary's* engine, there was great waste of steam by the condensation occasioned by the water on the surface whereof the steam acted: in *Newcomen's* engine, there was great loss of time and of fuel, by the cooling of the cylinder by the water injected to condense the steam: the steam also was of no further use, after having raised the piston to the required height. Hence,

4. Mr. *James Watt* of Glasgow, now of Birmingham, after much reflection and experiment, introduced the following improvements.

He condensed the steam in a vessel separate and at a distance from the cylinder; which is now no longer cooled by the injection-water, as in *Newcomen's* or the atmospheric engine.

He makes an approximation to a vacuum by pumping

out the air, which always, to a certain degree, accompanies the steam, and by its elasticity re-acts against the under side of the piston.

He keeps the outside of the working-cylinder, hot, by the intervention of steam between it and a casing.

He contrived the parallel motion, by which the piston and the upright rod attached to it and connected with the beam, preserves its perpendicularity during the stroke.

He depressed the piston by letting in steam above and upon it, instead of leaving it to descend by the pressure of the atmosphere, thus doubling the duty performed by the steam, and gaining in power and frequency of stroke.

He kept the top of the piston, hot, by means of a casing between the piston and the outward air; so that the steam let on above, is always of the same temperature with that let in below the piston.

He consumed the smoke of the fuel, by making it pass through and over the red hot coals: thereby converting the carbon and the carburetted hydrogen of the smoke into fuel; and preventing the bottom of the boiler from being covered with soot, which is a non-conductor of heat.

He supplied the boiler with the hot-injection water.

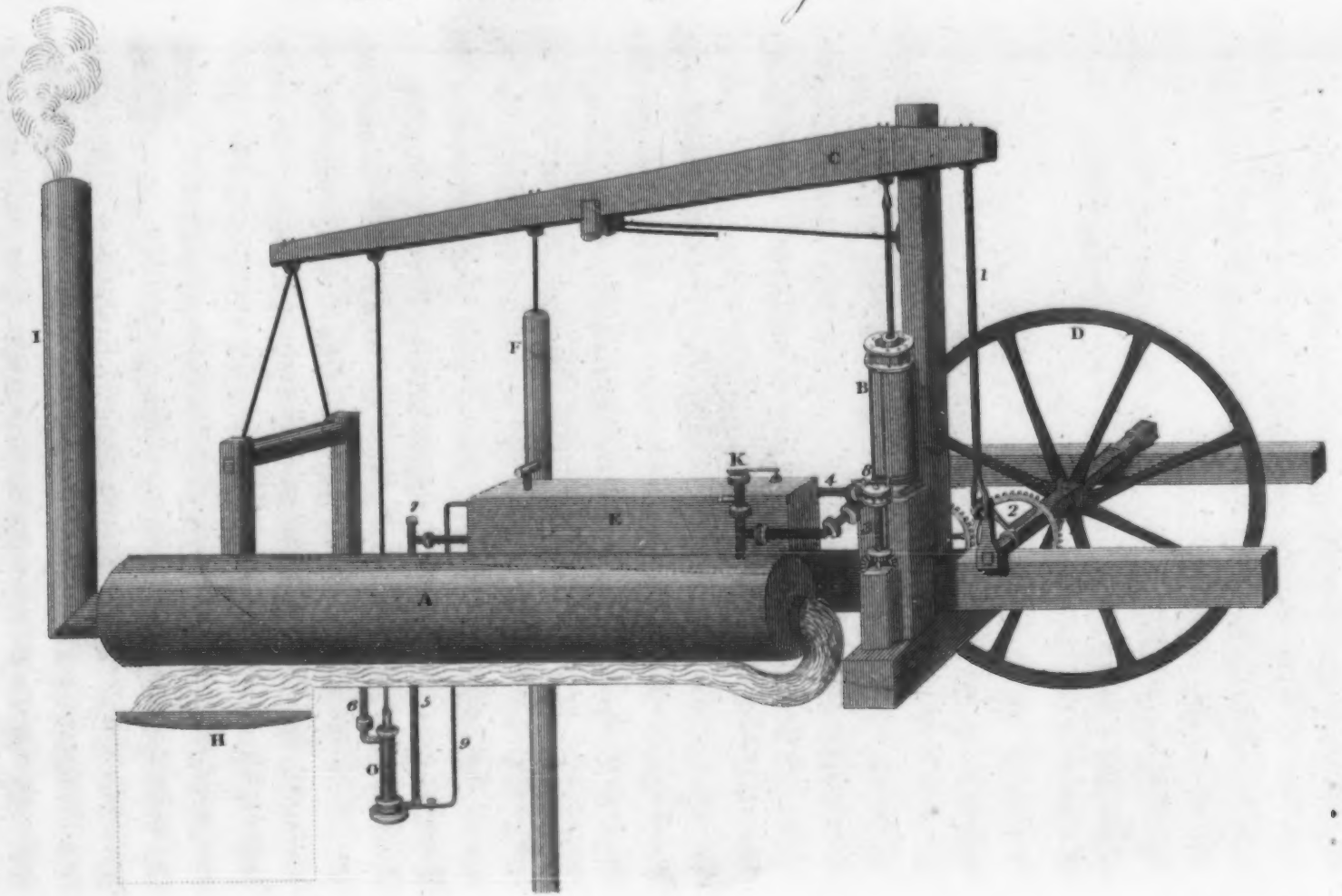
He applied two pipes or tubes inserted into the boiler at different depths; and furnished with cocks; by means of which, it can be ascertained when the boiler is too full, by its throwing out water, or too empty, by its throwing out steam.

He improved the method of letting the hot-injection water into the boiler as need required, by opening the valve with a floating stone instead of the ball-cock.

He first gave perfection to the rotatory motion by the Sun and Planet wheels connected with the fly.

He sedulously aimed at perfection in every part of the workmanship of the engine, which in his case became much superior to any antecedent engine.

The Columbian Steam Engine.



J.H. Hewlett &c.

Mr. *Watt* connected himself with Mr. *Matthew Boulton*, of the Soho Manufactory at Birmingham; and his son and Mr. *Boulton's* son, still carry on the business. It has been calculated, near ten years ago, that his engine has produced to the nation a saving of 75,000*l.* sterling per day: perhaps it would not be extravagant to calculate it at this moment at 25 millions a year. Mr. *Watt* was born in the latter end of 1736 or the beginning of 1737. He is, I believe, yet alive.

M. Prony who has published two large quarto volumes on hydraulic architecture, has dedicated nearly one of them to the description of *Watt's* steam engine, without having once mentioned Mr. *Watt* as the introducer of these great improvements, and indeed without even mentioning his name. He mentions the *Perriers* who in 1779 purchased from *Boulton* and *Watt*, one of these engines to supply part of the city of Paris with water: they erected it about a mile and a half from Paris on the road to Passy. One would conjecture from *Prony's* account, that the *Perriers* had the merit of constructing this engine, for neither Mr. *Watt* or Mr. *Boulton* is noticed. In the year 1792 young Mr. *Watt* and myself, went to look at *Perrier's* engine, and the person who shewed it, gave us to understand it was *Perrier's* contrivance altogether. This robbery of other people's merit is disgracefully common in that country.

The ingenuity of the English, however, was perpetually exerted in the improvement of this great national invention. I shall notice briefly, the chief improvements or proposed improvements.

Among the persons who early suggested alterations in this machine was the Reverend Mr. *Cartwright*, author of the beautiful poem of Armine and Elvira, and who has since brought to perfection, the application of the steam

engine to the whole process of weaving. His improvements consist in

5thly. A new and ingenious method of giving the necessary perpendicular motion to the piston-rod.

In condensing the steam, by expanding it in a very thin surface between hollow metal balls cooled withinside the inner one, and withoutside the outer one by cold water; so that a great surface of steam is exposed to the action of cold, as a great surface of wick in *Argand's* lamp is exposed to an inside and outside current of air.

He attempted to save much trouble usually necessary in packing the piston, by fitting accurately a metal piston to the cylinder, by means of springs that keep the piston in close contact with the inner side of the working cylinder.

As he pumps up all the steam thus condensed, into the boiler—and as this steam is condensed without intermixing with the cold water used for condensation, his principle admits of the use of ardent spirits, if this liquid should at any time or for any reason be preferred.

I do not know whether Mr. *Cartwright's* engines are much in use. An account and drawing of it, I have already given; another engraving of it may be found in 1 Tilloch's Philos. Mag. 1.

6thly. Mr. *Hornblower's* improvements do not seem to consist in the adoption of any new principle, for reasons stated by Professor *Robison*, in the article steam engine in the Edinburgh Encyclopædia, p. 771, (which with the supplement ought to be perused) but in the methods used to make his collars air tight—in the structure of his condensing vessel, and in the framing of his beams. A plate of *Hornblower's* engine is given by Professor *Robison* in that article, and by Dr. *Gregory* in the second volume of his Mechanics.

7thly. Mr. *Sadler's* improvements consist

In his working without a lever and beam. Also

Part of the steam previous to condensation is employed a second time in another cylinder, the piston of which is depressed by the atmosphere. In this second application it performs the office of an air pump, and adds to the total force of the machine.

Mr. *Hornblower*, as may be seen by his patent which I have inserted, early proposed the use of the steam in a second cylinder previous to condensation; which has also been adopted by Mr. *Woolf*. I do not find that any engineer, has superceded the use of the beam previous to Mr. *Sadler*. But whether his engine is in vogue or not, I cannot say. There is no beam to the portable engine of Mr. *Clegg*, of which I have given a plate. The method of giving rotatory motion adopted by Messrs. *Long* and *Hauto*, of Germantown, if it succeeds will also supercede the necessity of the beam. Their other principle, of giving motion by the pressure of a column of water confined in a pipe, has been used in France about the year 1731, and afterward in Cornwall: since that by Mr. *R. Trevethick*, at the Druid copper mine near Truro, in Cornwall; and has been applied to packing goods by Mr. *Brama*, of London. See 1 Nich. Jour. 8vo. p. 161.

8thly. Mr. *R. Trevethick's* steam engine, seems constructed on the plan of using steam at a very high temperature, and letting it escape without condensation. The accident that happened to one of his engines, and of which I have given an account, has brought them into disrepute, to a certain degree, but I see no objection to the principle, which may be applied with perfect safety if reasonable caution be used in the construction of the apparatus, and in working it.

9thly. Portable steam engines have lately become fashionable. *Watt* and *Boulton* make them of all sizes:

Clegg's and *Murray's* appear to me entitled to consideration.

10thly. But Mr. *Woolf* of London, seems to have gone farther in improving this machine than any other person, since the patent of *Boulton* and *Watt*.

He has more accurately than his predecessors, ascertained the law of the expansion of steam, by a volume for each pound per square inch on the safety-valve. Hence,

He can use his steam at a higher temperature than it is used in the common engine of *Boulton* and *Watt*, and more under the command of accurate calculation.

He uses it twice over in separate cylinders; though it seems to me, that there is nothing novel in this part of his process.

He applies heat to the hot steam in the second cylinder: using oils, or metalline substances of easy fusibility as the mean of communicating and preserving heat to the steam: this part of his patent seems to me original; though the same idea was communicated by Chancellor *Livingston* to Dr. *Priestley*, but whether previous or subsequent to *Woolf's* patent I cannot now say.

He has contrived a safety-valve, and a method of measuring the elastic force of steam, which I have thought deserving of being communicated by a plate.

He has superceded the necessity of such frequent packings of the piston, by a contrivance of which I have given a general account, referring to the publication where a plate of it can be found.

He has given a substitute for a fly wheel, that in certain situations will doubtless be useful; but I have thought it sufficient to refer to the description, 6 Nichols. Jour. p. 218.

He has lately introduced a new principle by making the steam press in the first instance on a body of oil, which re-acts, as I understand it, against the bottom of

the piston; and when the force of the steam is taken off by condensation, the piston descends forcing the oil back into its former situation, and so on alternately. The oil of course is kept hot. In this way any escape of air among the steam to re-act against the motion of the piston is doubtless prevented: but I have not been able to procure the specification at length, and therefore cannot pretend to accuracy concerning it.

His boilers are of a new, and, as I think, a greatly improved form. Of this improvement I have given a description and a plate.

All these improvements are open to our own engineers. The time is now come, when a *civil-engineer* will be in general demand, and will meet with the success in point of fortune, and the respect in point of situation in society, which the able men of this description are sure to find in Great Britain. The three great requisites of a civil engineer, are first a profound knowledge of mathematics, and an habitual facility of applying mathematical principles and calculations to mechanics and machinery. Secondly, a full knowledge of the modern science of chemistry. Thirdly, an habitual facility in drawing and designing with neatness and accuracy. To these should be added, actual observation and study of the principal machines in use and their application.

I have given Mr. *Oliver Evans's* description of his steam engine, but for want of his patent-specification, I am not able to point out precisely, what part of it he claims as his peculiar invention. I shall be glad to insert such a precise specification of his claim when I am enabled so to do.

For the present, I conclude the article of STEAM ENGINES.

ON THE ART AND METHOD OF BRICK-MAKING.

THE manufacture of bricks was never carried on so extensively as at present, through the rage, not only for building but for improvement in the metropolis, and throughout the suburbs and every town in the united kingdom. Amongst most articles of British manufacture we see a gradual improvement upon the methods and systems of former times, and the principles of building under the architects of the present day are brought to a state of perfection not to be rivalled by future ages, but, strange as it may appear, the texture and durability of the most essential requisite for building, bricks, instead of being in a state of improvement, according to the science of building, are in a retrograde state, and far inferior to those of ancient times.

Brick-making, of late years, has furnished a very considerable branch of trade around the metropolis, not only very productive to the land-owners, but it has produced an extensive help to the revenue of the country; yet much of the brick now in use will hardly wear out a twenty-one years lease. That there must be something radically wrong in the present system of manufacturing the brick earth is very evident, as we have the same means of procuring brick earth equally fit for the purpose as formerly. With this impression, at the instigation of one of our correspondents connected with building, we think it may be beneficial to those concerned to lay before them the theory and practice of brick-making, as drawn up some time since by Mr. James Malcom.

He observes, that the manufacture of them is of the utmost importance to the community, inasmuch as the value and comfort of our dwellings must depend in a great measure on the quality of the materials with which

they are constructed; and bricks form no inconsiderable part of them. I say it is material to us, because if the bricks with which our houses are now almost uniformly built are in quality defective, and if the timber be of a similar description, we ought not to place much dependance on the solidity of the edifice.

The soil on the Surrey side of London is only calculated for certain sorts of bricks, and these, it must be confessed, are inferior to those made in Middlesex. We have neither depth, nor that pure medium argillaceous substance, which is so essential to form the perfect brick; we have either too much silex, or, to speak the common language, too much flinty sand; and the stones are too abundant, large, and too near the surface, which cause the bricks to vitrify, and thereby their colour and quality is injured; or we have a portion of calcareous matter, which causes the bricks, after being taken from the clamps, insensibly to moulder away by exposure to the air or to moisture; and where it is argillaceous, as in Camberwell and Dulwich parishes, it is to that extreme, as to be impossible to be moulded without the assistance of some adventitious combinations. What those combinations are, which form the several varieties of bricks manufactured in the county, together with some cursory remarks, will form the subject of this essay.

Synopsis.—At Kennington, at Walworth, at Camberwell, and in Battersea parishes, we have manufactories of bricks to a much greater extent probably than all the rest of the county united. In analyzing the earth which has been generally used, I followed the plan of the learned bishop of Llandaff. Eight ounces of earth taken out of the pit as they were digging it (Mr. Fentiman's), and moulding it into an oblong square, I placed on the hob of a Bath stove in my study, where a constant fire was kept for seven days. I then weighed it, and found it had lost one

ounce and three quarters. I did the same by that at Walworth, and during the same time it lost nearly two ounces; that at Camberwell lost in the same time three ounces four pennyweights; that at Battersea, two ounces six pennyweights. In the solution of these earths, after having exposed them to the muriatic and the acetous acid, it was evident that, besides a large portion of pure argil which the earth at Camberwell contained, there were not less than eighteen parts in one hundred of iron, a small portion of silex, and about six parts in one hundred of calcareous earth: and it will be seen, that the quantity of water which the clay and the calcareous earth held was considerable; from this I infer, that although the colour of the bricks, and the difficulty and consequent expence in moulding the latter was greatly against the manufacturer, yet, as to the materials, they were far superior to the others in an essential property, I mean durability. Those at Kennington and Walworth were nearly similar in their products, the latter possessing the most argil; and those at Battersea still more; the earth therefore imbibing more moisture, consequently loses more in burning.

The moulds used in making every sort of brick for building purposes are ten inches in length, and five in breadth; and the bricks when burned usually measure nine inches in length and four and one-half in breadth, so that the clamp shrinks about one inch in ten. But the degree of contraction (as we have before seen) which clay undergoes in being burned, does not absolutely depend upon the purity of the clay; for as some clay imbibes more moisture than others, if that which imbibes the most is not exposed a much longer time to the frost to divide and separate its particles, and to the heat of the sun to exhale its moisture, than that which imbibes less and is a shorter time exposed, it follows, that while the one

will be reduced one inch, the other may lose two or more. Again, the heat of the kiln or clamp, and the situation of the bricks as to heat, will vary the diminution of the subject to be burnt. It is of consequence, therefore, in the making of sound hard bricks, that the clay should be dug two or three years before it is used, in order that it may be pulverized; and the oftener it is turned and incorporated, the better will be the bricks. The earth should have sufficient time to mellow, ferment, or digest, which will render it more apt and fit to temper; and this operation of treading and tempering ought to be performed more than doubly what is usual, because the goodness of the bricks wholly depend upon the well performance of its first preparation, since the earth in itself before it is wrought, is generally brittle, full of extraneous matter, which requires to be removed, and as it were without unity and stability; but by adding small quantities of water by degrees to it, and working and incorporating it together, the several parts of it are opened, and by being thus exposed to the atmosphere a tough gluey substance is formed, which, without such tempering, treading and beating, could not have been produced. I can only compare this preparation of the soil to that of making bread. When there is a due quantity of water put to the flour, and well wrought up together, such bread becomes not only smooth and firm, without having eyes or being subject to crumbling, but it eats sweeter and mellower, and becomes easier of digestion, affording far better nourishment than such as is over-watered, heavy, and not sufficiently tempered; provided the other operations, which belong to the making of good bread, such as baking, &c. be properly performed.

Bricks thus tempered become solid, smooth, hard, and durable; and one brick thus made takes up nearly as much earth as a brick and a half made in the common

way; but these are light, full of cracks, and spongy, owing to the want of due working and management; and the mixing of ashes which is now the uniform practice about London, and light sandy earth which is usually practised in the country, to make them work easy, and with greater dispatch, serves also to save coals or wood in the burning them.

The excellency of bricks consists chiefly in the first and last operation; for bricks made of good earth, and well tempered, become solid and ponderous, and therefore will take up a longer time in drying and burning than our common bricks seem to require. It is also to be observed that the well drying of bricks, before they are burned, prevents cracking and crumbling in their burning; for when the bricks are too wet, the parts are prevented from adhering together. The best way of ordering the fire is, to make it gentle at first, and increase it by degrees as the bricks grow harder. If those several operations were properly and duly attended to we should not see such immense waste, and so great a profusion of unburnt and half burnt bricks, called place bricks, as we constantly find on the outsides of our modern clamps. For want of due precaution the fire never reaches them in an equable degree, and therefore they ought to be totally disregarded and laid aside; but modern ingenuity, and the tricks of the builders, have found out a mode of using them less objectionable to be sure than if they were consigned to the outside walls, though properly they are not fit to be used any where. It is necessary that the public should be informed, that these place bricks are now made use of in the inside walls of houses of every denomination, from the hut to the palace; and that they are soft, subject to very quick-decay, and wherever wet can at all get to them, they moulder away with great rapidity; nor is this the only objection to them; they are subject to be acted upon

by every change of the weather, so that the walls become damp, and the plastering discoloured, causing the bond timbers and plates to rot; and for want of equal solidity with the external bricks the walls crack, the timbers swag, because the bearing on them cannot be then any where equally poised.

The dampness which so often affects the inside walls is attempted to be palliated, or removed, by the introduction of what is called battening, whereby an opening or cavity is left between the brick-work or plastering; but whoever has attentively observed the result of this invention, which in very many instances has fallen to my lot to notice, will see that the damp arising from these bricks engenders mould, and is visible on the frame of the wood used in the battening; this mould is no doubt the secondary cause of the dry rot, since the origin must be in the bricks themselves.

That this is the case may be deduced from this fact, that wherever a quantity of those bricks is heaped up together for any length of time, they will upon separation be found to have their bases covered with a fine white net-work, especially those which are nearest the bottom. Hard burnt sound bricks never have this net-work grow upon them, let them lay as long as they may in any situation. This net-work then is the plantulæ of mould. The origin and increase of mould is nearly in proportion to the heat of the atmosphere; its appearance and vegetation are never more sudden than during the summer, and the reason seems to be, that the heat of the weather necessarily draws out the redundant moisture from the bricks, for want of a due circulation of air. This moisture attaches itself to the outside of the bricks, and there remains, the heat not being sufficient to dry it up, but enough perhaps to produce a degree of warmth; it enters into a slow but certain process of fermentation; and, pass-

ing through a state of acidity to putrefaction, is of itself sufficient to engender mould. Sometimes it is very long before mould is produced on particular substances, either from the absence of the seed, or the substance not being well adapted for its vegetation; while in others, the seed has been known to vegetate in three hours. The mould from being first white turns yellowish, and at last blackens. As it approaches a state of maturity, a kind of black dust falls from it, which is the seed of the plantulæ; a quantity of this dust constitutes the powder, which blackens the hand when touched. As this dust and seed is so fine and infinite, it spreads with a rapidity equal to the state and condition of the substances which may be fit to receive it, and hence may attack a whole building, and become the means of endangering and eventually destroying the most superb edifice.

Another fact will confirm this reasoning. In pulling down the most ancient houses not an atom of dry rot has been visible, but merely a decay in the timbers occasioned by age, because the bricks inside and out were alike hard and sound: but where modern ones have been erected on the old sites, a very few years have been sufficient to prove, that symptoms of dry rot have manifested themselves in the basement, from the great degree of humidity which prevails there.

If such bricks therefore are not timely removed, all the art of man cannot prevent the effects of the dry rot: it is the same with certain sorts of stone, which are always damp, be the weather what it may, and there the dry rot makes the greater havock.

Besides the bricks made at the places before-mentioned, there are some made at Tooting, of common stocks, at Mr. Brodie's; at Croydon, by Mr. Cooper; some very good white bricks, and geometrical tiles, at Reigate, by Mrs. Lucock; at Send Turnpike, by Mr. Daws; at

Brook, in the parish of Witley, by Mr. Mitchell; at Wilderwick, by Mr. Avery. The common computation is, that every acre will yield one million of bricks in every foot in depth, which also includes ashes that are usually mixed with it. In general our fields are shallow with a bottom of gravel, yet I think they will average nearly five feet, though I believe we have none that will run ten, twelve, or more feet as about Kingsland, at least such is my information, as well as observation.

There is a duty imposed on bricks by three acts of parliament, of five shillings for every one thousand of bricks payable by the maker, who is allowed ten for every one hundred when charged in the field, before burned, in compensation for all waste, loss, or damages; and the duty must be paid in six weeks. Also,

	s.	*d.*
For every 1000 plain tiles - - -	4	10
For every 1000 pan tiles, or ridge tiles -	12	10
For every 100 paving tiles, not exceeding ten inches square - - - -	2	5
If exceeding ten inches, an additional duty of	4	10
For every 1000 tiles, other than the above, by whatever name known - - -	4	10

The price is as under, (1810).

	s. *s.*
Best washed malm or marl stock	50 to 60 per 1000
Seconds - - -	40 to 50
Picked grey stocks - -	30 to 36
Common ditto - -	26 to 30
Place ditto - - -	21 to 24
White bricks - -	64
White geometrical tiles - -	64
Red tiles - - -	40

MANUFACTURE.—Bricks are made by the thousand, as the most satisfactory mode between master and man;

and a handy man can mould in one day, viz. from five in the morning until eight at night, five thousand. To assist him in the preparation of the soil, &c. from the heap (which is usually dug after the season for brick-making is over and laid up) there is generally a gang consisting of six persons; one man (but sometimes a woman) tempers and prepares the soil, which is done with a hoe made long, in the shape of a mattock, a shovel, a scoop, a thick plank or board, and a cuckhold; with the hoe he pulls down the soil from the great heap, which is chopped backwards with the shovel, to turn it as often as may be necessary, to mix and thoroughly incorporate the ashes and soil together (because it is to be understood that at the time the soil is dug out, and made into this heap, a layer of coal ashes is alternately placed between a layer of soil, as often and in such quantities in each layer as the quality of the soil and other circumstances may make necessary.) The scoop is used to throw water over this portion that is pulled down with the hoe, in order that it may become more and more in a tempering state, more soft and ductile; and with the board he kneads it together, over which a certain quantity of sand is thrown, and it is then covered with pieces of sacking or matting to keep the sun and air from it. A boy of ten or twelve years of age scoops or cuts off a slice with an instrument or shovel having a short handle, and the blade of it made concave, called a cuckhold, which he brings on his arms to the moulding table, which is placed under a moveable shed, upon which a girl of the same age rolls out a lump somewhat bigger than will fit the mould, the table having been previously strewed with sand. The moulder, after dipping his mould into dry sand placed at one corner of his table, throws the lump prepared by the girl into the mould, and with a flat smooth stick about eight inches long, previously dipped in a pan

of water, strikes off the surplus soil; he then immediately turns out the contents of the mould upon a stand or board of the same size with the brick. A boy takes it from thence, and places it on a light barrow, with a lattice-work frame fixed over the frame of a long barrow, at about three feet high above the wheel, and reduced to about eighteen inches in height towards the handles, forming an inclined plane. The new made bricks are placed on this latticed frame, and over them sand is thrown in sufficient quantities to prevent their adhering to each other, as well as to prevent, in a certain degree, their cracking in drying while on the hacks. A girl wheels the barrow to the hacks, and places them with great regularity and dispatch one above the other, a little diagonally, in order to give a free passage to the air. Each hack is made wide enough for two bricks, to be placed edgeways across, with a passage between the heads of each brick; they are usually made eight bricks high, the bottom bricks at the end of each hack are usually old ones.

In showery weather, wheat or rye straw is carefully laid over the bricks that are drying on these hacks, to keep them as free from wet as possible: for the brick-makers do not here, as in places more distant from the metropolis, go to the expense of roofed coverings, or long sheds, which from the extent of one of these fields would be impossible.

If the weather is tolerably fine, a few days is sufficient to make them dry enough to be turned, which is done by resetting them more open, and turning them; and six or eight days more are required before they are fit to be put into the clamp, for kilns are not in use in this part of the county. When sufficiently dry, the clamp-maker levels the ground, generally at one end of the range of hacks nearly centrical, making the foundation of the in-

tended clamp somewhat higher than the surrounding ground: and with place bricks, if they have any unsold, or otherwise with the driest of those just made, makes a foundation of an oblong form, beginning with the flue, which is nearly a brick wide, and running straight through the clamp. In this flue dry bavins, coals, and cinders (vulgarly called breese) are laid and pressed in close, in order that the interstices between wood and coal may be properly filled up. On the sides of the flue the bricks are placed diagonally about one inch asunder, and between each layer of bricks three or four inches of breese are strewed, and in this manner they build tier upon tier as high as the clamp is meant to be; never omitting between each layer, as well as between each brick, that is placed diagonally, to put a due portion of breese. When they have made the clamp about six feet long, another flue is made similar in every respect to the preceding, to the extent of the size of the intended clamp; provided only that the bricks are meant to be burnt off quick, which they will be in about twenty-one or thirty days, according as the weather may suit. But if there is no immediate hurry for the bricks, the flues are placed at about nine feet asunder, and the clamp left to burn off slowly. When fire is set to the clamp, and it burns well (the ash-hole being placed at the west end generally) the mouths are stopped with brick, and clay laid against them; the outsides of the clamps are plastered with clay if the weather is at all precarious, or the fire burns furiously; and to the end against which addition is made to the clamp, skreens made of reeds worked into frames about six feet high, and sufficiently wide to be moved about with ease, are placed to keep off the weather, and against any particular side where wet is most prevalent. On the top of the clamp a thick layer of breese is uniformly laid.

This is the mode of manufacturing the common grey stocks for walls and common buildings; but some brick-makers, in order to mix the soil and ashes more regularly, perform it with a machine, called a clay-mill, which a horse turns round. This machine consists of a tub or tun fixed to the ground, in which is placed perpendicularly an instrument resembling a worm or screw; the soil being put in at top is worked down by the rotary motion of the worm, and is forced out at a hole made on the side near the bottom of the tub. A man supplies the tub with fresh soil, properly moistened, while the person who supplies the moulder keeps removing that which is thus prepared, or pressed out.

Washed malms, or more properly marls, are made with still greater attention: a circular walled recess is built about four feet deep and from three to four feet wide, paved at bottom, and from ten to twelve feet diameter, having a horse-wheel placed in the centre; the ground is raised all round it, and a platform made upon a level with the top of the recess. On this platform the horse walks, a pump is fixed into a well, as near to the platform as may be, to supply the recess with water as often as occasion may require. A harrow made to fit the recess, and thick set with long iron teeth, well loaded, is chained to the traces of the horse, who drags this after him; a man wheels a barrow full of soil previously prepared in a heap the same as for the common stocks, and shoots it regularly round the recess, he then pumps a certain quantity of water, which, by means of troughs or shoots, runs on it, and sets the horse in motion. The harrow being loaded accordingly, forces its way into the soil, admits the water into it, and by thus tearing and separating it, mixes the ingredients at the same time that it gives an opportunity for stones and other ponderous substances to subside to the bottom. The man keeps supplying it

with fresh soil and water until there is a sufficient body in the recess. On one side, but as near to the recess as possible, the ground is made smooth, and dug out about eighteen inches or two feet deep into a hollow square; and the soil now becomes paste, and being thereby sufficiently washed, purified, and fluid, troughs are placed from the recess to this hollow ground, and it is ladled out with scoops or shovels into the troughs, carefully leaving the sediment at the bottom of the recess to be afterwards thrown out on the sides of it, together with stones, bones, &c. Over this hollow square or pit the fluid soil diffuses itself, where it settles of an equal thickness, and remains until wanted for use, the superfluous water being either evaporated or drained from it, by its being exposed for a certain length of time in so thin a body. When they have got a sufficient quantity of washed earth in this pit, another is made alongside of it, and so they proceed until they have got as much thus prepared as they are likely to want during the season.

The clamps for burning these better sort of bricks are individually the same with the others, but greater care is taken in not overheating the kiln, but in causing it to burn moderately, as equably and as diffusively at the same time as possible.

In the country, bricks are always burnt in kilns, whereby less waste arises, less fuel is consumed, and the bricks are sooner burnt. The bricks are first set or placed in it, and then the kiln being covered with pieces of bricks or tiles, they put in some wood to dry them with a gentle fire: and this they continue until the bricks are pretty dry, which takes up two or three days, which is known by the smoke turning from a darkish colour to a transparent smoke; they then leave off putting in wood, and proceed to make ready for burning, which is performed by putting in brush, furze, spray, heath, brake, or fern fag-

gots, according to the scarcity or plenty of some of those articles in the neighbourhood. But before they put in any faggots they dam up the mouth or mouths of the kiln with pieces of bricks, which is called in some places shinlog, piled one upon another, and close it up with wet brick earth.

The shinlog they make so high that there is but just room above it to thrust in a faggot; they then proceed to put in more faggots, till the kiln and its arches look white, and the fire appears at the top of the kiln; upon which they slacken the fire for an hour, and let all cool by degress. This they continue to do alternately, heatening and slackening till the bricks be thoroughly burnt, which is usually effected in forty-eight hours. One of these kilns will burn twenty thousand bricks, and is usually thirteen feet long, by ten feet six inches in depth, and the height about twelve feet. The walls are carried up something out of the perpendicular at top, and inclining towards each other, so that the area at the top is not more than one hundred and fourteen square feet; the thickness of the walls are one foot two inches.

The bricks are set on flat arches, having holes left in them something like lattice work.

Goldham observes that bricks will have double the strength if, after one burning, they be steeped in water and burnt afresh.*

As every man who has occasion to use bricks, whether on his own estate, or on that of his landlord, cannot but be sensible of the great value of a perfectly dry house; and as I think I have shewn that it is impossible a house can be dry if bricks are used which are insufficiently burnt, such as the place bricks I have before described, he will do well to consider whether it will not be more advantageous to him in the end, to make use of no other than the

* Common *earthen* ware, can be converted into *stone* ware, by reburning. T. C.

very best hard sound bricks, be the colour of them what they may, and be the cost what it will. Such bricks are easily known by their sound, and by their striking fire with steel. It will be found that, besides the comfort and firmness of the building, they will be cheaper than place bricks, together with the expense of battening the walls.

In the interior of the country tiles are almost uniformly used for roofs of houses, and in some instances on barns; but between Dorking and Horsham a heavy but very durable sort of slate stone is used. Nearer London either Welch or Westmoreland prevail. As there are many persons who give the preference to tiles, it may not be amiss to know the result of a curious experiment on that subject as related by the Bishop of Llandaff.

"That sort of slate, other circumstances being the same, is esteemed the best which imbibes the least water; for the imbibed water not only increases the weight of the covering, but in frosty weather, being converted into ice it swells and shivers the slate. This effect of frost is very sensible in tiled houses, but it is scarcely felt in slated ones; for good slate imbibes but little water; and when tiles are well glazed they are rendered, in some measure, with respect to this point, similar to slate. I took a piece of Westmoreland slate, and a piece of common tile, and weighed each of them carefully; the surface of each was about thirty square inches; both the pieces were immersed in water for ten minutes, and then taken out and weighed as soon as they had ceased to drip; the tile had imbibed above a seventh part of its weight of water; and the slate had not imbibed a two-hundredth part of its weight; indeed the wetting of the slate was merely superficial. I placed both the wet pieces before the fire; in a quarter of an hour the slate was become quite dry, and of the same weight it had before it was put into the water; but the tile had lost only about twelve grains of the water it

had imbibed, which was, as near as could be expected, the very same quantity which had been spread over its surface; for it was the quantity which had been imbibed by the slate, the surface of which was equal to that of the tile; the tile was left to dry in a room heated to sixty degrees, and it did not lose all the water it had imbibed in less than six days."

The finest sort of blue slate is sold at Kendal, for 3*s*. 6*d*. per load, which comes to 1*l*. 15*s*. per ton, the load weighing two hundred weight. The coarsest may be had for 2*s*. 4*d*. a load, or 1*l*. 3*s*. 4*d*. per ton. Thirteen loads of the finest sort will cover forty-two square yards of roof, and eighteen loads of the coarsest will cover the same space; so that there is half a ton less weight put upon forty-two square yards of roof when the finest slate is used than if it was covered with the coarsest kind, and the difference of the expense of the material is only 3*s*. 6*d*. To balance in some measure the advantage arising from the lightness of the finest slate, it must be remarked that it owes its lightness, not so much to any diversity in the component parts of the stone from which it is split, as to the thinness to which the workmen reduce it; and it is not able to resist violent winds so well as that which is heavier.

A common Cambridge tile weighed thirty-seven ounces: they use at a medium seven hundred tiles for covering one hundred square feet, or about two and a half tons of tile to forty-two square yards. Hence, without including the weight of what is used in lapping over, &c. when a building is covered with copper or lead, it will be seen that forty-two square yards of building will be covered by

Zinc about - - -	1 cwt.
Copper - - -	4
Fine slate - - -	26
Lead - - - -	27

Coarser slate - -	36
Tiles - - - -	54

From the foregoing statement it is evident, that we are obliged to make our plates and rafters of the roof so much stouter and heavier than there is any occasion to do for slates, even the coarser sort; and consequently this increased strength in the timber must add to the expense of the roof, supposing that the same thickness of wall be sufficient."

Brick-Making.—I add a few remarks, the result of my own observation, which may furnish some notions of the value of brick-earth.

When my father died about 1789, he owned forty acres of land at Kentish town, then two miles from the turnpike of Tottenham Court Road, London. It is now built over. He had let out four acres of that land containing brick earth, at a price then considered greatly too cheap: viz. one hundred pound sterling per acre for the brick earth: the brick-maker paying 5*l.* sterling per acre for all the rest of the field that he occupied in brick-making; and being bound to fill up the holes or excavations from whence the brick earth was taken, level with the rest of the field, within one twelve month after the brick earth was exhausted. The rubbish for this purpose was usually procured from old buildings pulled down and repaired in London, brought as back loading.

The bricks made there, were *place bricks* and *gray stocks.* The place bricks being the outside bricks of the kiln, inferior, ill-burnt, soft, and used for the inside of walls. The grey stocks, being the bricks used about London, for common front-work. The colour a reddish brown.

Malm-Stocks, used for arches, were made partly near Brompton, and partly in Norfolk, of a finer kind of clay previously washed to separate the large particles of stone

or sand; and when burnt, were of a whitish colour. They were easily ground down to the required dimensions for the arch. The term *malm*, is a corruption of the old word *malin* or *marle*.

By act of parliament of 17 G. 3. ch. 4. all bricks made for sale, shall, when burned, be not less than 8 inches and a half long, 2 inches and a half thick, and four inches wide. A well burnt brick of statuteable size will weigh about 9lb.

The process of brick-making is tolerably well detailed in the preceding pages. The brick earth is thrown up in the fall of the year to mellow through the frost of the winter. It is then (in spring) worked up by labourers upon a levelled earthen floor, into a well mixed uniform moist mass. Each layer of the brick earth of about six inches thick is covered with a thin layer of *breeze*, or sifted ashes. This should be explained.

In London, where nothing but coal is used, and where the small Newcastle coal, that gives out comparatively little flame, but cakes or cements into a solid cinder, is usually preferred, the ashes under the grate contain a great deal, not only of the coak of coal, but also of the small coal itself, that in stirring the fire, passes through. The scavengers, who are also frequently brick-makers, usually contract to clean the streets, and take away the ashes from each house as often as required; this contract is by the parish. I can well remember when the parish of St. James, Westminster, paid the scavengers 700*l.* sterling annually for this service, and in the course of five years, received 1200*l.* sterling for the privilege. These ashes being sifted, the finer parts are mixed as above noticed with the brick earth, and the coarser parts are used as fuel to burn the clamp: The fine ashes and coal dust thus mixed with the brick, certainly serves to assist its being *thoroughly* burned.

When the contractor, found the moulds, sand for moulding, the breeze for mixing and burning, he could get all the labour performed from moulding the brick, to delivering it well burnt in the clamp for 11*s.* 6*d.* sterling per thousand. The bricks so made, he delivered at any reasonable distance in London for 25*s.* 6*d.* sterling per thousand, he paying a duty also of 2*s.* 6*d.* per thousand.

Bricks made in a close conical kiln, are much better than in an open clamp, and the saving of waste will in time pay for the kiln. In this country, the faults are, 1st. The earth contains too much stony matter, generally: 2dly. The drying in the air, the skintling, is not continued long enough: 3dly. The bricks are seldom thoroughly burnt to the centre, for want of the admixture of breeze.

The profit upon a thousand bricks was very great, and would well justify much more than 100*l.* sterling per acre for good brick earth. A cube yard of good brick earth, I think, would make about 500 bricks when well worked and mixed.

Plain tiles and pan tiles, usually made of a stiffer and more ochry clay, are not used with us. I have seen a substitute used in England, which I think would well answer here: viz. a kind of tile about nine inches by four inches, made of coarse pasteboard about one fourth of an inch or one half of an inch thick, and when fully impregnated with glue, covered with fine sifted sand. This would be light, impervious to moisture if a small quantity of wax were melted in the glue, and not easily set on fire, or rather not capable of being burnt. T. C.

METHOD OF MANUFACTURING ISINGLASS.

THE following paper was formerly published by Dr. Mease, in his Archives. I think proper to publish it also; for Isinglass at three dollars a pound is a sufficient inducement to find a substitute, which, in my opinion, may be found in almost any fish. It is a great pity that fish-soup should be so little used in cookery, so excellent as it is. A glue having many properties of isinglass, I have made from the dried skin of Eels, from the heads of Cat-fish, from the heads of Shad thrown away, from the Susquehanna Salmon or Bass, and from Perch. I do not know how isinglass dissolved, differs from any common fish gelly in its chemical qualities, but it is more tasteless, and therefore for some purposes more eligible. T. C.

Method of Manufacturing Isinglass.—While isinglass is such an essential in a variety of British manufactures and preparations, and for which we are indebted chiefly to importation, the following account of the method of making it, will not only be entertaining, but furnish some useful hints for British ingenuity, in procuring a substitute equal to that imported from Russia —it is taken from an account published in the 63d vol. of the Philosophical Transactions, by Humphrey Jackson, Esq.

The secret of isinglass rested a long time solely with the Russians, and made from the fish *Huso*, or isinglass sturgeon; and its name in Greek signifies fish-glue, viz. Ichthyocolla. All authors who have hitherto delivered processes for making fish-glue, or isinglass, have greatly mistaken both its constituent matter and preparation. To prove this assertion, it may not be improper to recite what a writer of the name of Pomet says on the subject, as he appears to be the principal author, whom the rest have

copied. After describing the fish, he says, as to the manner of making the isinglass, the sinewy parts of the fish are boiled in water till all of them be dissolved that will dissolve, then the gluey liquor is strained and set to cool. Being cold, the fat is carefully taken off, and the liquor itself is boiled to a juicy consistency, then cut to pieces and made into a twist, bent in form of a crescent, as commonly sold, then hung upon a string and carefully dried. From this account it might rationally be concluded that every species of fish, which contained gelatinous principles, would yield isinglass; and this parity of reasoning seems to have given rise to the hasty conclusion of those who strenuously search for the extraction of isinglass from sturgeon, but as that fish is easily procurable, the negligence of ascertaining the fact, by experiment, seems inexcusable. In my first attempt to discover the constituent parts and manufacture of isinglass, relying too much upon the authority of some chemical authors, whose veracity I had experienced in many instances, I found myself constantly disappointed. Glue, not Isinglass, was the result of every process; and although in the same view, a journey to Russia proved fruitless, yet a steady perseverance in the research proved not only successful as to this object, but in the pursuit to discover, resinous matter plentifully procurable in the British fisheries, which has been found by ample experience to answer similar purposes. It is now no longer a secret that our lakes and rivers of North America are stocked with immense quantities of fish, said to be of the same species with those in Muscovy, and yielding the finest isinglass; the fisheries whereof, under due encouragement, would doubtless supply all Europe with this valuable article.

No artificial heat is necessary to the production of isinglass; neither is the matter dissolved for this purpose, for as the continuity of its fibres would be destroyed by

solution, the mass would become brittle in drying, and snap short asunder, which is always the case with glue, but never with isinglass; the latter indeed may be resolved into glue with boiling water; but its fibrous composition would be found impracticable afterwards, and a fibrous texture is one of the most distinguishing characteristics of genuine isinglass. A due consideration, that an imperfect solution of isinglass, called *Finings* by the brewers, possessed a peculiar property of clarifying malt liquors, induced me to attempt its analysis in cold subacid menstruums. One ounce and a half of good isinglass, steeped a few days in a gallon of stale beer, was converted into good finings of a remarkably thick consistence. The same quantity of glue, under similar treatment, yielded only a mucilaginous liquor, resembling diluted gum-water, which instead of clarifying beer, increased both its tenacity and turbidness, and communicated other properties in no respect corresponding with those of genuine finings. On commixing three spoonfuls of the solution of isinglass with one gallon of malt liquor in a tall cylindrical glass, a vast number of curdly masses became presently formed by the reciprocal attraction of the particles of isinglass and the feculencies of the beer, which increasing in magnitude and specific gravity, arranged themselves accordingly, and fell in a combined state to the bottom through the well known laws of gravitation; for, in this case there is no elective attraction, as some have imagined, which bears the least affinity with what frequently occurs in chemical decompositions.

If what is commercially termed *long* and *short stapled isinglass* be steeped a few hours in fair cold water, the entwisted membranes will expand and reassume their original beautiful hue,* and by a dexterous address may be

* If the transparent isinglass be held in certain positions to the light, it frequently exhibits beautiful prismatic colours.

perfectly unfolded. By this simple operation we find that isinglass is nothing more than certain membranous parts of fishes divested of their native mucosity, rolled and twisted into the forms above mentioned and dried in the open air.

The sounds or air bladders of fresh water fish in general are preferred for this purpose, as being the most transparent, flexible, delicate substances. These constitute the finest sorts of isinglass; those called *book* and *ordinary staple* are made of the intestines, and probably of the peritonæum of the fish. The belluga yields the greatest quantity, as being the largest and most plentiful fish in the Muscovy rivers; but the sounds of all fresh-water fish yield more or less fine isinglass, particularly the smaller sorts, found in prodigious quantities in the Caspian sea, and several hundred miles beyond Astracan, in the Wolga, Yaik, Don, and even as far as Siberia, where it is called *kla* by the natives, which signifies a glutinous matter; it is the basis of the Russian glue, which is preferred to all other kinds for its strength. The sounds, which yield the finer isinglass, consist of parallel fibres, and are easily rent longitudinally, but the ordinary sorts are found composed of double membranes, whose fibres cross each other obliquely, resembling the coats of a bladder; hence the former are more readily pervaded and divided with subacid liquors, but the latter, through a peculiar kind of interwoven texture, are with great difficulty torn asunder, and long resist the power of the same menstruum; yet when duly resolved are found to act with equal energy in clarifying liquors.

Isinglass receives its different shapes in the following manner:

The part of which it is composed, particularly the sounds, are taken from the fish while sweet and fresh, slit open, washed from their slimy *sordes*, divested of

every thin membrane which envelopes the sound, and then exposed to stiffen a little in the air: in this state they are formed into rolls, about the thickness of a finger, and in length according to the intended size of the staple, a thin membrane is generally selected for the centre of the roll, round which the rest are folded alternately, and about half an inch of each extremity of the roll is turned inwards. The due dimensions being thus obtained, the two ends of what is called *short staple*, are pinned together with a small wooden peg, the middle of the roll is then pressed a little downwards, which gives it the resemblance of a heart shape, and thus it is laid on boards or hung up in the air to dry. The sounds which compose the *long staple* are longer than the former; but the operator lengthens this sort at pleasure by interfolding the ends of one or more pieces of the sound with each other: the extremeties are fastened with a peg like the former, but the middle part of the roll is bent more considerably downwards, and in order to preserve the shape of the three obtuse angles thus formed, a piece of round stick, about a quarter of an inch diameter, is fastened in each angle with small wooden pegs, in the same manner as the ends. In this state it is permitted to dry long enough to retain its form, when the pegs and sticks are taken out, and the drying completed; lastly, the pieces of isinglass are collected in rows, by running pack-thread through the pegholes, for convenience of package.

The membranes of the book sort being thick and refractory, will not admit a similar formation with the preceding; the pieces therefore, after their sides are folded inwardly, are bent in the centre in such a manner that the opposite sides resemble the cover of a book, from whence its name; a peg being run across the middle, fastens the sides together, and thus it is dried like the former. This sort is interleaved and the pegs run across

the ends, the better to prevent its unfolding. That called *lake isinglass* is formed of the bits and fragments of the staple sorts, put into a flat metalline pan, with a very little water, and heated just enough to make the parts cohere like a pancake when it is dried, but frequently it is over-heated, and such pieces, as before observed, are useless in the business of fining. Isinglass, is best made in the summer, as frost gives it a disagreeable colour, deprives it of weight, and impairs its gelatinous principles; its fashionable forms are unnecessary, and frequently injurious to its native qualities. It is common to find oily putrid matter and *exuviæ* of insects between the implicated membranes, which through the inattention of the cellerman often contaminate wines and malt liquors in the act of clarification. These peculiar shapes might probably be introduced originally with a view to conceal and disguise the real substance of isinglass and preserve the monopoly, but as the mask is now taken off, it cannot be doubted to answer every purpose more effectually in its native state, without any subsequent manufacture whatever, especially to the principal consumers, who hence will be enabled to procure sufficient supplies from the British colonies. Until this laudable end can be fully accomplished, and as a species of isinglass more easily procurable from the marine fisheries may probably be more immediately encouraged, it may be manufactured as follows:

The sounds of cod and ling bear great analogy with those of the *accipenser* genus of Linnæus*—and are so generally well known as to require no particular description.

The Newfoundland and Iceland fishers split open the fish as soon as taken, and throw the back bones with the sounds annexed in a heap. But previous to incipient

* Acipenser Huso.

putrefaction, the sounds are cut out, washed from their slimes and salted for use. In cutting out the sounds the intercostal parts are left behind, which are much the best; the Iceland fishermen are so sensible of this, that they beat the bone upon a block with a thick stick, till the pockets, as they term them, come out easily, and thus preserve the sound entire. If the sounds have been cured with salt, that must be dissolved by steeping them in water before they are prepared for isinglass; the fresh sound must then be laid upon a block of wood whose surface is a little elliptical, to the end of which a small hair brush is nailed, and with a saw-knife the membranes on each side of the sound must be scraped off. The knife is rubbed upon the brush occasionally to clear its teeth; the pockets are cut open with scissars and perfectly cleansed of the mucous matter with a coarse cloth; the sounds are afterwards washed a few minutes in lime-water, in order to absorb their oily principle, and lastly in clear water. They are then laid upon nets to dry in the air, but if intended to resemble the foreign isinglass, the sounds of cod will only admit that called *book;* but those of ling of both shapes. The thicker the sounds are, the better the isinglass, colour excepted; but that is immaterial to the brewer, who is its chief consumer. This isinglass resolves into fining, like the other sorts, in subacid liquors, as stale beer, cyder, old hock, &c. and in equal quantities produces similar effects upon turbid liquors, except that it falls speedier and closer to the bottom of the vessel, as may be demonstrated in tall cylindrical glasses; but foreign isinglass retains the consistency of fining preferably in warm weather, owing to the greater tenacity of native mucilage. Vegetable acids are, in every respect, best adapted to fining; the mineral acids are too corrosive, and even insalubrious in common beverage.

It is remarkable, that during the conversion of isinglass into fining, the acidity of the menstruum seems greatly diminished, at least to taste; not on account of any alkaline property in the isinglass probably, but by its inveloping the acid particles. It is likewise reduceable into jelly with alkaline liquors, which indeed are solvents of all animal matters; even cold lime water dissolves it into a pulpous *magma*. Notwithstanding this is inadmissible as fining, on account of the menstruum, it produces admirable effects in other respects; for, on commixture with compositions of plaster, lime, &c. for ornamenting walls exposed to the vicissitudes of weather, it adds firmness and permanancy to the cement; and if common brick mortar be worked up with this jelly, it soon becomes almost as hard as the brick itself; but for this purpose it is more commodiously prepared, by dissolving it in cold water, acidulated with vitriolic acid; in which case, the acid quits the jelly, and forms with the lime a *selenetic* mass, while at the same time the jelly being deprived in some measure of its moisture, through the formation of an indissoluble concrete amongst its parts, soon dries, and hardens into a firm body, whence its superior strength and durability are easily comprehended.

It has been long a prevalent opinion, that Sturgeon, on account of its cartilaginous nature, would yield great quantities of isinglass; but on examination no part of this fish, except the inner coat of the sound, promised the least success. This being full of *rugae*, adheres so firmly to the external membrane, which is useless, that the labour of repeating them supercedes the advantage. The intestines, however, which in the larger fish extend several yards in length, being cleansed from their mucus and dried, were found surprisingly strong and elastic, resembling cords made with the intestines of other animals, com-

monly called *cat-gut*, and from some trials, promised superior advantages when applied to mechanical operations.

Isinglass is also of great use in medicine, and cookery.

EXPERIMENTS ON GLUE MAKING.

To the editor of the Tradesman, or Commercial Magazine.

SIR *Berwick, 8th June*, 1809.

ON looking over the 7th Number of your Magazine, I observe a letter from Perth, with some observations on making glue. I am not so perfectly acquainted with the process of glue making as to give complete directions to any person wishing to embark in that manufactory, but making experiments on a variety of substances, which seemed likely to be converted into that article, engrossed much of my attention for some years. Some of my experiments may possibly excite a smile from the professed chemist, but at the same time I am persuaded that they may be of some use to the practical experimentalist, and may possibly save a great deal of both time and trouble to any who may be inclined to pursue the same object. My time would not admit of putting down in writing the twentieth part of my experiments, but the result of the most conspicuous is perfectly fresh in my memory.

I learn one useful lesson from your correspondent, which is, we should never be too confident, that we have collected all and every information which a town, a certain district, or journey may procure, however minute our observation and enquiries may have been; I had no idea that there was a town or village, either in the north or south, but some person knew that all sorts of animals' skins, and every kind of leather, (except such as had re-

ceived less or more of the tanning,) was easily capable of being converted into glue, or boiled down into a jelly, which is adopted to various useful purposes without going through the full process of glue making. What first engrossed my attention, was the vast quantities of scraps and parings of tanned leather thrown away from curriers' work houses, and every shoemaker's shop. What struck me was, that if any means could be fallen on to extract the tan, that all these which are at present thrown to the dunghill, might be converted to a valuable purpose.

My first experiment was to steep a quantity of small pieces of tanned leather in water, renewing it regularly before it came to a state of putrefaction, as whenever that takes place, the substance of the leather is rendered entirely unfit for the intended purpose; but while any of the tan seemed to remain in the leather, the water kept fresh a very long time: how long I continued this, I cannot exactly say, but at least six or nine months. The water at last came off perfectly clear, and the leather seemed so soft and pliable, I had some hopes my object was obtained; but when boiled after the manner of dissolving other leather, I found that in place of dissolving into a soft or pulpy-like substance, it turned hard and brittle; if the boiling was long continued, it separated into a kind of corney substance, or into small particles, but never dissolved so as to intermix with the water. My next experiment was putting the leather into a weak solution of different acids: I thought it possible that some of these might either dissolve the tan, or at least be more powerful in extracting it than pure water; this was very often repeated, and at each renewal the leather was carefully washed with water, to prevent its being in any degree corroded by the acid. The same experiment was tried with a solution of alkali, but when the operation of boiling was again resorted to, the appearances were more unpromis-

ing than the former. My last experiment was steeping the leather with a certain quantity of fuller's-earth; this, of all the other substances which I tried, seemed to produce the best effect. In length of time the tan appeared to be entirely taken out, and the leather seemed as soft and had nearly the same feel as when taken from the animal; but when I reverted to the boiling, although the appearances were much more favourable, the desired effect was by no means produced: what effect longer perseverance might have had, I cannot determine, for I now began to tire. My curiosity was next directed towards fish; I tried various experiments on almost every kind caught on these shores, and the result of all was nearly the same. I soon found that the skins and fins of fish are not difficult to boil into a kind of glue, and the substance was of a most adhesive and tenacious quality, but appeared to be too susceptible of the least damp, and soon became soft. The bones, if boiled for a considerable length of time, became so soft as easily to rub into a very fine white powder, but the fish itself exhibited the most curious appearances. I have often examined it with a glass of great magnifying powers, and the appearance is beautiful; the whole appears one pure lucid pulpy substance. I was, at first, confident, that the whole would, with ease, dissolve into a soapy substance, if not into glue, but how different was the result? after boiling a very long time, the whole dissolves into a thready substance, and although continued for several days, there was not the smallest difference, only the quantity reduced from its original bulk, yet the water never appeared in the least thickened, and when suffered to stand at rest, the whole settled to the bottom without shewing the smallest tendency to incorporate with the water. If a solution of either pot or pearl-ashes is used, the fish will easily melt down into a soft soapy substance, and the solution is made pretty strong, the dissolved sub-

stance will wash much the same as soft soap. I was still anxious (if possible) to fall on some method to dissolve fish without the intervention of any other substance but water. I put a certain quantity into a jar, which was kept perfectly close, till the whole was completely dissolved into a fine soft soapy mass, but the smell was so intolerable, it was almost impossible to examine it with much attention. I thought this a good opportunity to try the effect of alkali in a state of solution, to destroy any infection, or to counteract putrefaction. I mixed the putrefied fish with a weak solution of pearl-ashes, when I was most agreeably surprized to find the offensive smell destroyed in a few minutes; the only flavour which the fish retained, was resembling horn, which had got a small scorch with fire, but it was no way offensive or disagreeable.

I tried numerous other experiments relative to making glue, particularly with the common rosin, by mixing it with some substance, so as to make it soluble in water. Rice affords a glue mucilage, which in a certain degree effected that purpose; from linseed I found the same, &c. But I am afraid I have already tired your readers, who may feel very little interest in these matters; but of this I am certain, the chemical experimentalist will eagerly catch at every hint which may throw some light on the effect produced by the combination of different substances, and I can assure all those who have leisure time, that no study, I had almost said no amusement, will afford so large a fund of entertainment as chemical experiments. I well know that repeated disappointments will attend the most skilful operator, and the most plausible compounds will often produce a substance very different from what is expected; but even these very disappointments produce such appearances as doubly to increase our curiosity, and only gives a greater excitement to make farther experi-

ments. It likewise has this singular advantage, that while it amuses the mind, gratifies curiosity, and enlarges all the intellectual faculties, it in general gives a good deal of exercise to the body.

I am, Sir, your's, &c.
JAMES GRAHAM.

METHOD OF MANUFACTURING GLUE.

To the editor of the Tradesman, or Commercial Magazine.

SIR,

I HAVE observed in your seventh number a correspondent asking for particulars on the manufacture of glue, and again in your eighth number, page 114. In your thirteenth number, for July last, are also the results of several experiments on the clippings and parings of tanned leather, and fish bones, by Mr. James Graham, of Berwick; but I think the following process of making glue, as furnished by Mr. J. Clennell, of Newcastle, about the year 1802, is the most concise and simple of any I have read, and corresponds exactly with the practical part of that manufacture, of which I have been an eye-witness for several years, in the neighbourhood of Acton, on the road to Uxbridge. I will therefore make use of Mr. C's. own words.

"The improvement (he observes) of any manufacture depends upon its easy access to men of science, and a prudential theorist can never be better employed than in attempting to reduce to regularity or to system the manufactures that may fall under his attention. In conformity to the first principle, I made some notes whilst visiting a glue manufactory, a few years ago, in Southwark, and those interwoven with the remarks on that subject, of some chymists of the first respectability, I take the liberty of sending you; at the same time I must beg of you, or your correspondents, that where they may be corrected

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in any manner, it may be done, and I shall feel myself obliged by the attention.

"Glue is an inspissated jelly made of the parings of hides or horns of any kind, the pelts obtained from furriers, and the hoofs and ears of horses, oxen, calves, sheep, &c. quantities of all which are imported, in addition to the home supply, by many of the great manufacturers of this article; these are first digested in lime water, to cleanse them as far as it can from the grease or dirt they may have contracted; they are then steeped in clean water, taking care to stir them well from time to time; afterwards they are laid in a heap, and the superabundant water pressed out; then they are boiled in a large brass cauldron, with clean water, skimming off the dirt as it rises, and further cleansed by putting in, after the whole is dissolved, a little melted alum or lime finely powdered, which by their detersive properties still further purge it; the skimming is continued for some time, when the mass is strained through baskets and suffered to settle, that the remaining impurities, if any, may subside; it is then poured gently into the kettle again, and further evaporated by boiling a second time, and skimming until it becomes of a clear, but darkish brown colour: when it is thought to be strong enough (which is known either by the length of time a certain quantity of water and materials have boiled, or by its appearance during ebullition) it is poured into frames or moulds of about six feet long, one broad, and two deep, where it hardens gradually as the heat decreases: out of these troughs or receivers it is cut, when cold, by a spade, into square pieces or cakes, and each of these is placed within a sort of wooden box, open in three divisions to the back; in this the glue, as yet soft, is taken to a table by women, where they divide it into three pieces,* with an instrument not unlike a

* When the women by mistake cut only two, that which is double the size is called a bishop, and thrown into the kettle again to be manufactured afresh.

bow, having a brass wire for its string; with this they stand behind the box, and cut, by its opening, from front to back; the pieces thus cut are taken out into the open air, and dried on a kind of coarse net work, fastened in moveable sheds of about four feet square, which are placed in rows in the glue-maker's field, every one of which contains four or five, or more rows of net-work; when perfectly dry and hard it is fit for sale.

"That is thought the best glue which swells considerably without melting, by three or four days immersion in cold water, and recovers its former dimensions and properties by drying. Glue that has got frost, or that looks thick and black, may be melted over again and refined, with a sufficient quantity added of fresh, to overcome any injury it may have sustained; but it is generally put into the kettle, after what is in it has been purged in the second boiling. To know good from bad glue, it is necessary for the purchaser to hold it between his eye and the light, and if it appears of a strong dark brown colour, and free from cloudy or black spots, the article is good."—So far Mr. Clennell.

A glue that is colourless, and of superior quality, is obtained of the skins of eels, and known by the name of *size*. It is also procured from vellum, parchment, and different species of white leather; but for common purposes this is by far too expensive, and is only made use of in those cases of delicate workmanship where glue would be too gross. The skins of the rabbit, hare, and cat are also made use of in the manufacturing of size, by those who are employed in gilding, polishing, and painting in various colours.

Another fine species of glue is known by the name of *isinglass*, and is the produce of a certain fish very common in the Russian seas. From various foreign writers on the subject of glue, it appears that it was first principally pre-

pared from the membranous and cartilaginous parts of animals, and after being dried, they were melted into tablets. It is certain, however, that every animal substance containing jelly may be used in the manufacture of glue; and, according to Duhamel, a strong but black-coloured glue may be obtained from bones and hartshorn, after they are dissolved in Papin's digester. The English glue, is reckoned far superior to any kind manufactured abroad, and furnishes an article of exportation to the continent; and the Dutch society of arts and manufactures have long offered premiums for a specimen equal to the English, the Flanders glue being considerably inferior to that manufactured in England, and that manufactured in France is still worse.

From the experiments of Parmentier, it appears that six pounds of button-maker's raspings yielded a pound of excellent glue, not inferior to that which is manufactured in England. The glue which he obtained from the filings of ivory was equally good, but more highly coloured. The filings of horn yielded none of this substance. To obtain glue as colourless as possible, a very small quantity of water should be employed for extracting the jelly, by which means it may be concentrated without long evaporation, as exposure to heat has always a greater or less influence on the colour in proportion to the time. The whiteness and transparency of the Flanders' glue are said to originate from an adherence to this plan.

In their consistence, colour, taste, smell, and solubility, glues are found to differ from each other considerably. Some glues will dissolve by agitation in cold water, while others are only soluble at the point of ebullition. It is generally admitted that the best of glue is transparent, of a brownish yellow colour, and having neither taste nor smell. It is perfectly soluble in water, forming

a viscous fluid, which, when dry, preserves its tenacity and transparency in every part, and has more solidity, colour, and viscidity, in proportion to the age and strength of the animal from which it is produced.

Glue is of the greatest use in many of our principal manufactories, particularly that of hats.

EBOR.

Remarks by the Editor.—Near Philadelphia the process is this. The cuttings parings, &c. of skins, and other materials that will boil to a jelly, are immersed for 2 or 3 days in lime water, to take off the hair. They are then washed well. They are put in a coarse canvass bag, suspended by a chain from a large iron arm fixed in the brickwork. The bag is immersed in the boiler of water: the materials are gradually dissolved. The feculences, add to the dung heap. The solution is evaporated till on trial being cold, it is gelatinous; in this state, while hot, it is poured into long wooden moulds somewhat broader than the usual breadth of a piece of glue. It is then cut into lengths while in the box, by children, who take out the solid mass of jelly, being a little longer, a little broader than the usual size of glue-cake, and thick enough (the depth of the wooden trough, box, or mould) to make half a dozen cakes of glue. It is then carried and placed before the man who cuts it. This is done by a square frame with brass wires, set at such distance apart, that each cutting will make a cake of glue. By one motion, pressing the brass wires through the jelly toward his breast against which a board is placed, half a dozen, (or if necessary, more) cakes of glue, or rather of jelly, are cut and separted at once. These are carried away, put upon netting under a shed, and dried gradually in the air: by which means, the jelly is hardened into glue.

This business, cannot be carried on, but between Sep-

tember and May, on account of the materials being so liable to putrefaction. For the same reason they omit no Sundays, the necessity of the business requiring it. I think about 2lb. of rosin per hundred weight, would make the glue better, and enable the manufacturer to work a month longer.

On the Art of covering Wire Cloth with a transparent Varnish, as a Substitute for Horn; and on other Objects of public Utility. By ALEXIS ROCHON, *of the National Institute of France, &c.**

IN the progress of the present war, the marine storehouses of France were totally without the essential article of horns for lanthorns. It was impossible to substitute glass in the place of this article, on account of its brittleness, and the obvious danger which might result from that quality. In this situation of distress, the agents of the French government consulted Citizen Rochon, and directed him to make every experiment he could think of to discover a proper substitute. His attention was first directed to a memoir of the celebrated Poivre on the fabrication of lanthorns of horn by the Chinese. It is known that this industrious nation prefer horn to glass on account of its cheapness and toughness, and that they possess the art of welding this substance together with so

* Extracted from a memoir read to the National Institute of France the 21st Ventose, in the year VI. (March 11th, 1798), and inserted in the Journal de Physique for April 1798. The memoir contains various political and economical observations more particularly applicable to France, with general observations, which I have not thought it necessary either to transcribe or abridge; neither have I been solicitous to take the very words of my author in the parts I have abstracted. N.

much delicacy, that they make lanthorns of two feet diameter of astonishing transparency, and to all appearance of one single piece. It is also known that the Chinese use the horns of goats and sheep only, which they soften and split into laminæ by processes supposed to be unknown in Europe; or, perhaps, by employing a proportion of human labour and patience for that purpose which the European demand might be inadequate to repay. Citizen Rochon, who does not appear to be perfectly aware of the degree of accuracy with which the same art of splitting horn is practised in Europe, proposed, that the horns of beeves should be sawed into laminæ, and then scraped and polished; or, to which he gives the preference, that they should be laminated in boiling water.

While this active philosopher was employed at Brest in establishing a manufactory for laminating the horns of beeves, which he purposed to reduce into the state of a paste by means of pure alkali in the digester of Papin, it occurred to him, that he might supply the pressing wants of the navy by another expedient, which consisted in the application of a coating of glue upon wire cloth.

In this process, he at first tinned the iron wires of the sieve cloth he made use of, but afterwards found it more convenient, in every respect, to give it a slight coating of oil paint to preserve it from rust. The glue he made use of was afforded by boiling the clippings of parchment with the air-bladders and membranes of sea-fish; materials which he used, not from any notion that they were preferable to isinglass, but because they were the cheapest he could procure. He added the juice of garlick and cyder to his composition, in proportions which, I suppose, he did not measure, but which he found to communicate great tenacity and somewhat more of transparence than it would have possessed without them. Into this transparent and very pure glue or size, he plung-

ed his wire cloth, which came out with its interstices filled with the compound. It is requisite that the size should possess a determinate heat and consistence, concerning which, experience alone must guide the operator.

When this prepared wire cloth is fixed in the lanthorn, it must be defended from moisture by a coating of pure drying linseed oil; but even in this state it is not fit to be exposed to the weather. The ease with which these lanthorns are repaired in case of accident, by a slight coating of glue, is pointed out as a great advantage by the inventor, who likewise informs us that they were used in the expedition to Ireland as signal lanthorns, though contrary to his wishes. For this use he recommends the large plates of mica, which were then imported from Boston. With the latter substance, enclosed between two pieces of very open wire cloth, he made certain squares, 26 inches in length and 18 in width, for the light-house at Ushant, which had been damaged by a flock of wild ducks, that flew through the windows and dashed out the lights.

Citizen Rochon affirms, that lanthorns of wire cloth, prepared in his method, are much cheaper than those made of tin and horn; that they are very cheaply repaired, and afford a stronger light.

He applied coarse iron wire cloth to another use, which, he thinks, may be worth attention in future. He made the roof of one of his workshops of this wire-cloth in order to avoid the danger of fire, and covered it with a slight coating of plaister. He thinks that a composition of lime and pounded scales of iron would have been preferable. This coating ought not to be thicker than a slate; and he recommends that it should be penetrated with boiling whale oil, and painted with tar and ochre. Such a roof would afford no hold for the wind, and might, as he apprehends, be of considerable use to defend buildings and sheds which require particular defence against fire.

In the course of experiments made for the discovery of a varnish proper to defend his new lanthorns from moisture, Citizen Rochon did not employ resins or copal, which are always somewhat friable, but a perfect solution of elastic gum in drying linseed oil. This varnish or unguent having fixed the attention of Genouin, that learned chemist demanded whether it might not be practicable to use it in making bougies and other medical instruments, which were also at that time very much wanted. From this suggestion, Rochon employed the English machine for weaving whips to make the more consistent part of the instrument. He plunged this woven piece in a mixture of melted wax with a little ochre, then drew it through a wire plate to take off the superfluous wax, and render it perfectly smooth; after which he applied the varnish of elastic gum, which completed the instrument.

Sartori, ornamental painter at Brest, pointed out to our operator that fish glue is preferable to parchment size upon open wire cloth, because it is more transparent and stronger.

ROPE MAKING.

Mr. John Curr's (Sheffield), Patent, for laying a Rope, or twisting and forming the Strands together that compose the round Rope.—"Presuming (says Mr. Curr) that there is in use a wheel, or engine, for twisting the strands at the top end of the ropery, and another moveable one towards the bottom end of the ropery, and that the large tooth-wheel, in each of these wheels that drive round the small nut-wheels, contain ninety-four teeth each; and that there are three smaller nuts working into the tooth-wheel of the wheel, or engine, at the top end of the rope-

ry occasionally, that contain fourteen teeth each; and three more that contain twenty-five teeth each; and three more that contain fifty teeth each; which are also occasionally put into geer for twisting up the strands, or for laying a rope to accommodate different sizes and dimensions of ropes; and that there are three small nut-wheels working into a tooth-wheel, above described, of the wheel, or engine, at the bottom end of the ropery, occasionally, that contain eight teeth each, and three more that contain fourteen teeth each; and three more that contain twenty-eight teeth each; which are also put into geer for twisting up the strands, or for laying a rope to accommodate different sizes and dimensions of ropes. Now, in order to lay, or twist a shroud-laid rope regularly, from end to end, and to keep the fore-twist of the strands and the back-twist of the rope always regular, this invention requires that a wheel, or reel, or other apparatus, shall be attached to the wheel, or engine, at the lower end of the ropery above described, in such a manner as to point out and command the speed of the moveable top, or laying-block, commonly used in laying a rope. And the nut-wheels, at the top-end of the ropery employed in twisting the strand, should be so proportioned to the nut-wheels, employed at the same time in twisting the rope at the bottom end, as that it shall require an equal number of turns on the wheel at both ends of the ropery, to give the proper twist or hardness to the rope, so that the workmen making one revolution or turn of the one wheel, or engine, at the same time as the workmen do on the other end, a regular proportion of twist is effected and kept up.—To simplify these principles, a view of the wheel, or reel, is prefixed to the specification.

The strands being all then put upon the axis of the nut, with 14 teeth on the engine, at the bottom end of the ropery, and upon the separate nuts with 25 teeth on the

wheel, or engine, at the top end; the wheel, or reel, on which the cord or wire laps, being fixed to the diameter of eighteen inches and a half, for a rope of three inches circumference; and both wheels, or engines, being turned with the same velocity, or, in other words a revolution being made of the wheels at the bottom and top end of the ropery, at one and the same time (which, as they are in sight of each other, may easily be done), the cord, or wire, will then turn off the reel, and govern the speed of the top, which will produce a rope nearly regular, in twist and in hardness. To make a shroud-laid rope of greater or less circumference than the third-inch rope above described, the diameter of the wheel, or reel, will require to be lessened or enlarged two inches in diameter for every three-eighths of an inch the ropes are more or less in circumference, in which case, the twist of the rope will be found tolerably near the twist of a hard-laid rope, and close a cable-laid rope on these wheels, or make a shroud-laid rope of larger circumference than four inches and a half. The three strands may be put upon the nut-wheel, at the bottom end of the ropery, containing twenty-eight teeth; and the single strands upon the wheel, at the top end, with fifty teeth; in which case the wheel, or reel, will be fixed to half the diameter of the above directions. If the above-mentioned proportion of teeth does not harden the rope, to the discretion of the ropemaker, the nuts at the top-end, with a tooth less each, will make the ropes harder; and with a tooth more each will make them softer; and lessening, or enlarging the wheel, or reel, gives more or less twists in the rope. The ropes being thus made, by a regular system, will, if the spinning be well done, and if the rope-maker, in getting the strands to the full hardness, be careful to cease twisting when the moveable wheel, or engine, at the bottom end of the ropery, is at one and the same place with each

of the strands, to give the same hardness to all of them, and the ground on which the sledge, that holds back the moveable wheel or engine, at the bottom end of the ropery works, to keep the strands in proper tension, be regular and even, be very nearly regular in twist and hardness, from end to end; and for the cable-laid ropes, consisting generally of three small shroud-laid ropes, or for making flat-ropes, all of which require the ropes being made to great accuracy, that they may all take a regular stretch together, when applied to use, will be found a great acquisition and improvement in the strength and wear of them; and in any detached shroud-laid rope this regularity in the manufacturing will be found of great service.

TEA TRAYS.

A Composition for making Trays, Waiters, and various Articles by Presses or Stamps,

By Mr. Thomas Jones, of Bliston, Staffordshire. The ingredients used are varied according to the size of the articles to be manufactured. For those that are small, he takes 1000lbs. of rope, 20lbs. of rags, and for large articles 100lbs. of rope, and 100lbs. of rags are added. These are reduced to a pulp, and mixed with a certain small proportion of vitriolic acid. Various other materials are mentioned, but those above stated are deemed the best; and to make the said pulp into different articles, Mr. J. recommends that a wire or other sieve of a similar size and shape to the article required, to be taken and used in the manner directed in the specification. To render the mode of operation intelligible, the Patentee has given an example, shewing in what way the frame and sieve are placed

to collect the composition or pulp for making an oval canoe. He then puts on a flannel or woollen cloth, and upon that a board, and then turns the pulp out of the sieve upon the flannel and board upon the top of it, and presses the same together lightly, to force out part of the liquid by which the pulp felt is made. This being between the dies or tools of the shape of the articles wanted, is put into a press, in order to render it at once solid, and of the required shape. It is now to be put into a stove or oven of a proper degree of heat, where it is kept till it is nearly, but not entirely dry, and then it is to be taken out of the oven, put between the dies and pressed violently, so as to set it and make it smooth. After this it is put into the oven again till it is perfectly dried; but great caution must be used to prevent it from warping; this is effected by means of a frame, made in the form of the inside of the articles, and weights to keep it in its proper form. It may next, if necessary, be hammered over to make it smooth and flat, and then being perfectly dry, it is to be dipped in the Japan liquid, and there suffered to remain till the said liquid has perfectly penetrated it, when it is to be dried and varnished. The dies may be made of iron, or any other metal, or hard substance.

REMARKS BY THE EDITOR.

The preceding series of papers on isinglass, glue, rope making, and tea trays, suggest methods of saving scraps and fragments that would otherwise be thrown away as useless. The parings of leather might be further applied, as in England, to the making of snuff boxes, pocket inkstands, segar boxes, &c. The articles are reduced to shavings, macerated in warm water, and pressed in moulds of the required shape and size. They are then dried and varnished, the black with black japan, the brown with amber varnish.

In the hot summer of the year 1780 (the summer of the memorable Lord George Gordon Riots) I attended during the long vacation of the colleges at Oxford, a course of anatomical lectures under Mr. Sheldon (who afterward published on the anatomy of the lymphatic system.) After that course, I, with several other anatomical students, attended veterinary dissections at a repository for dead horses in St. John's, Clerkenwell. I there was taught how usefully the meanest and most trifling articles might be employed under the direction of scientific skill: and I have from that time ceased to wonder at the pre-eminence in manufactures which the English have obtained, who so well know the value of saving and of using, what the negligent ignorance of foreign artists would abandon as worthless. We have a tolerably good poem on the life and death of a blood horse, "The high mettled racer," tracing his progress from being the favourite of the turf, through all the grades of hardships, till he is worn out with hunger, labour and blows, in the cart of the scavenger; I fear, a faithful account, not much to the credit of British Humanity*. I will now trace the progress of a *dead horse* through all the stages of his posthumous utility, greatly to the credit of the skill and frugality of that most ingenious people, as economical manufacturers.

A gentleman's horse dies. The routine of disposing of the dead animal, is this.

He is sent to the sadler, who gives credit for him at a Guinea. The sadler gives notice to the currier, who has the horse conveyed to some repository for dead horses; where he is skinned, and the currier takes away the skin, leaving the carcase. The skin, is depiled by lime, drest and tanned in the usual way: the offal of the skin cut off

* I republished about three years ago, Lord Erskine's admirable speech on cruelty to animals: it well deserves frequent perusal.

by the currier is sold to the glue maker: the offal of the leather during the process or after tanning, is laid by and sold to the makers of snuff-boxes, &c.

The dead horse, is a subject for dissection to young students in comparative anatomy, who pay for the licence of going to the repository, a guinea a quarter. The flesh is then cut off, boiled, and sold to people who hawk it about the streets of London in wheelbarrows, as cat's meat and dog's meat, at 1 1-2*d.* per lb.

The hoofs, are sold to the makers of Prussian blue. The bones, are sold to two descriptions of manufacturers: 1st, to the makers of cart-grease, who reside at the outskirts of London, and boil the bones for the sake of the fat and marrow; which, when cold, is skimmed off, and mixed with an equal quantity of tar to make the composition necessary to grease carriage wheels. Or, 2dly, they are sold to the manufacturers of volatile alkali, who make spirit of hartshorn, and sal ammoniac out of them, by distilling in large iron cylinders. The bones thus boiled down, used in my time, to be sent back again to a steam mill near St. John's, Clerkenwell, where they were ground into a coarse powder, and sold as a top dressing for grain crops. T. C.

ON PATENTS.—BY THE EDITOR.

THIS subject is now becoming very important, and is intimately connected with the whole range of domestic manufacture. The number and nature of the patents granted under the laws of the United States, have hitherto contributed little to the improvement of manufactures, but threaten much to the increase of lawsuits and impositions. I propose to offer a few remarks on this topic: and as we are not likely to throw aside the lights we may acquire from British precedents, and British practices, I shall give a summary of the decisions of that country on this set of questions.

By the 6th section of 21 James 1. ch. 3. the enacting clauses of that statute against monopolies generally, are declared not to extend to letters patent, and grants of privileges for 14 years or under, thereafter to be made, for the sole working or making of any manner of *new* manufactures within this realm, to the true and first inventor of such manufactures, which others at the time of making such letters patent shall not use, so as also, they be not contrary to law—nor mischievous to the state by raising the prices of commodities at home—or hurt of trade—or generally inconvenient.

The following comprize all the cases of consequence on patent rights, not including the questions on the copy-right of authors. The cases in Godbolt are too obsolete to be noticed.

3 Inst. 184. 1 Hawk. 233, Birscot's case. In which, additions to known manufactures are said not to be entitled to patent. But this case was overruled by Lord Mansfield in Morris v. Branson.

5 Co. 94. a, Barwick's case: a false suggestion will avoid a grant.

Edgberry v. Stephens, Salk. 447. 1 Hawk. 233. Inventions imported from abroad, never before used at home, entitled to patent. I shall observe upon this doctrine presently. This is the foundation for the New York patent to Livingston and Fulton.

Rex v. Mussary, 12 Geo. 2. Buller, N. P. [75.]

Morris v. Branson, 1776, Buller, N. P. [77.] Stocking frame.

Liardet v. Johnson, 1778, Buller, N. P. [76.] Patent stucco: usually, but falsely cited as a case on a patent for elastic trusses.

Rex v. Arkwright, 1785, Buller, N. P. [77.] Cotton spinning.

Rex v. Else, 1785, Buller, N. P. 76.

Turner v. Winter, 1787, 1 Durnf. & East, 602. Patent mineral yellow.

Boulton and Watt v. Bull, 1795, 2 H. Blacks. 463. 3 Vez. 140. Court divided on the law. Steam engine.

Hornblower v. Boulton and Watt, in error, 1799, 8 Durnf. and East, 95. Steam Engine.

Harmer v. Plane, 1807, 14 Vez. 130. Woollen cloth.

Much of the discussion in the cases of Boulton and Watt consists of argument on the grammatical meaning of the words manufacture, machine, method, principle.

The points substantially determined by these cases, may be reduced to the following heads.

1st. No patent is valid, in England, for any thing contrary to law—for any thing mischievous to the state by raising the price

of commodities at home—for any thing hurtful to trade—or generally inconvenient.

2dly. No patent is valid for any manufacture or invention in use at home before.

3dly. No manufacture or invention in use before, can be prohibited, or stopped on account of any patent granted for a new invention.

4thly. The specification must be filed in chancery within the time prescribed.

5thly. The specification must be full and precise; sufficiently ample and intelligible in itself; and must contain a plain description of every article, mode, process, and method, necessary to enable an artist of reasonable skill in the subject matter, to succeed in imitating the invention specified; without further explanation, or the necessity of trying any preliminary experiment. This complete disclosure, being the consideration for which the temporary monopoly is granted. Turner's patent for making mineral yellow, was set aside for ambiguity. Sir Richard Arkwright's patent for his cotton-spinning machine, was set aside (as I recollect) on account of his omitting to specify a weight and the place of it, necessary to make the machine go. A patent for elastic trusses was set aside, because the temper of the steel was improved by greasing it, which the patentee, who used tallow for the purpose, concealed. Any mode of misleading the public by ambiguity, concealment, or falsehood in the specification—by the introduction of unnecessary articles or processes, or the suppression of such as are necessary, will be fatal to the patent right. The patentee must enable the public to use his invention upon as simple and easy terms as he uses it himself.

6thly. The specification must pointedly describe the precise invention or improvement on which the patent is grounded; so that the public may know specifically, what the artist claims as peculiar to himself: and in such manner, that any person contesting the patent, may be enabled to meet the precise claim of novelty. It must not intermingle what was known before, with what is claimed as new, so as to render the latter ambiguous. The invention must be distinguished from what was previously known.

7thly. If the patent be grounded on an addition to, or an improvement of what was in use before, the patentee must confine his claim distinctly to the addition or improvement; and not take out a patent including the inventions of others who have preceded

him, as well as his own; if he does, the patent is void. If the addition be to a machine or manufacture already patented, the last patentee cannot use the first without license, or the first patentee use the addition without license.

8thly. It does not seem fully settled, whether a patent can be supported for an *abstract principle* however new. Judicial opinions are divided on this head. Thus, the Marquis of Worcester in his Century of Inventions, mentions one, of an engine which can be set to work and kept at work by the mere force of steam arising from boiling water. Would the Marquis have been entitled to a patent, for the exclusive use of all engines and machines whereof the moving power was the force of steam?

The better opinion seems, not. The ways and means, the method or variety of methods, and the machinery, by which steam can be applied as a moving power, seems legally requisite to be set out, previous to the establishing of such a patent. Otherwise the public may rest in doubt whether this *can* be done; moreover the patentee who conceals his method of doing it, is hardly entitled to a patent.

But where the method of effecting this, is plain and obvious to an artist of common skill, so as not to need a particular description, the want of it will not vitiate the patent. Thus, the patent of Boulton and Watt, was finally established for condensing the steam in a reservoir or box at a distance and separate from the working cylinder; although the precise method employed by them was not described. I am however not prepared to acquiesce in this much litigated decision, without great hesitation. *Perhaps* if the method actually employed were described, it would so far satisfy the law, as to cover any other after-found method of putting in practice the same principle. But I offer this in great doubt.

Upon this head, it is worthy to be considered, that if a patent can legally be supported for a principle merely, no improvement however important in the method of putting it in practice, can be used during the existence of the patent-right. The monopoly is not merely a pecuniary tax on the community, but an obstacle also to future invention. Thus, if a patent had existed for the principle of raising water, or moving machinery by means of steam, and Savary's method had been used—none of Watt's improvements could have been brought into use during the patent-term. Hence the propriety of confining the patent to the *method* of doing the thing. Hence also patents are properly granted for

new, more simple, and effectual methods of using a well-known principle, as in steam engine patents.

But it should seem doubtful whether a *new application* of an old method or principle, ought to be a ground for a patent right, *unless it obviously requires considerable skill in varying the application.*

Thus, if a patent be granted for a new apparatus to distill aqua fortis, it would be absurd to grant another for its application to spirit of salt. If steam be applied to turn a cotton mill, it would be idle to grant another patent to one who applied it to a grist mill. The owners of the Albion mills never attempted to take out a patent. Perhaps its application to moving vessels on water, or carriages on land, would require machinery so different, as to furnish some foundation for a patent right; but in such case the specification and the claim, might include a description of the machinery used.

There is a colliery about four miles from the town of Leeds, in Yorkshire, from whence there is an iron rail road to Leeds. A friend of mine, lately from England, informed me, that he had seen a steam engine in a waggon on that rail road, drawing after it *twenty-two waggons*, each laden with three tons of coals; in all 66 tons. The wheels and the rail way, were reciprocally cogged. They moved at the rate of four miles an hour. Granting this to be, as I believe it is not, the foundation of a patent right, would any body support another patent for driving *coaches* by steam? Hence it should appear very difficult to lay down any certain rule on the subject. In England, the jury aided by the court, might determine whether a patent contested on the ground of frivolity ought to be supported, under the head of its being of general inconvenience. That is, as it now appears to me, for I find no judicial determination hereon. In this country, the question is becoming daily more interesting, where patents, frivolous, absurd, and fraudulent, threaten to become taxes on the community, in favour of persons, who may truly be said to raise money under false pretences.

9thly. A patent may be granted for an invention or improvement introduced from abroad: for the benefit is the same to the public, whether the knowledge be obtained by travelling, or by studying.

This is founded on the case in Salkeld, a very loose reporter. It may be right in the infancy of the communication of knowledge;

but I apprehend it is a doctrine, which must be received with some modifications in the present day.

For instance: could a patent have been supported in England, for the precise mode of bleaching by means of the oxymuriatic acid which every chemist in England was well acquainted with by the instructions of Berthollet?

Could any person in this country take out a patent for those inventions of Watt, that are included in his specification, when that specification is given at length in the reported cases of Boulton and Watt against Bull, and Hornblower against Boulton and Watt, and in the Repertory of arts?

The Repertory of Arts, the Philosophical Journals of Nicholson and Tilloch, the Magazines and Encyclopædias, of England, are books containing many english and continental inventions: they are books far from being uncommon in this country: they are open to all readers who will procure them: is it reasonable that a patent should be supported for any of the inventions described to the world and published for common benefit in either of these, or similar publications, in our own language?

If a patent be taken out, for an invention described in books known generally to scientific readers, I apprehend there is no sufficient reason to support it: the discovery is made and presented to the public, and belongs to the public: but if a process or method, or machine, or manufacture, not described in any book, be used in England or on the continent of Europe, and imported hither, there seems to be good reason for granting a patent right for its introduction.

So, though it were published in the French, German, Swedish, or Russian languages only: for at the present day, these languages, and the books published therein (French perhaps excepted*) are not commonly known even to scientific men in England or this country. If it be said, this would establish a fluctuating rule, I acknowledge it; but I contend that the rule ought reasonably to fluctuate with the advancements of science, and the facilities of scientific communication.

10thly. I do not find it any where determined, that the manufacture, engine, machine, method, process or principle for which a patent is takent out, should be in actual use and opera-

* I doubt whether the Annals de Chimie, the Journal de Rozier, the Journal des Mines, the Memoires D'Arcueil, the Reports of the National Institute, are sufficiently common, for my remarks to apply to them.

tion at the time of taking out the patent or filing the specification. I strongly incline to think, this ought to be the case, either at the filing of the specification or within some reasonable time after, according to the nature of the invention: but I do not find it laid down as necessary. How can it be ascertained that an invention is useful, and deserving of a patent right, till it be shewn to be so, by actual experiment? or why should a patentee enjoy his right to a monopoly, who leaves other persons at their own risk to ascertain the practicability and utility of the proposed invention?

11thly. Moreover, I think it may be inferred from the observations of some of the bench arguendo, that the person who merely suggests a theory or *principle*, is not entitled to a patent, but he only is so entitled, who first reduces it to practice and ascertains at his own expence of time, money and labour, the utility of the proposal. And this appears to me so reasonable, that I think it may well be adopted under some limitations. Sufficient time should be allowed to the first person who suggests an useful principle to reduce it to practice: a time, that must be limited according to the nature of the invention. A man can easily put together his improvements on the escapement of a watch, for instance; but a steam engine is not perfected in a week, or a month, or a twelve-month. If a man will permit his suggestions to lay idle and fruitless for years, he ought to be considered as having abandoned any exclusive right to them. Indeed all the common doctrine of abandonment, will apply to patents.

It is upon this principle, that the patent to *Livingston and Fulton* for their steam boats can be best defended. *Fitch* lost his right by abandonment through non-user. *Rumsey* did not succeed so as to bring his steam boat into full use. *Lord Stanhope* also failed in England. After these failures, the persons who succeeded, appear to have a reasonable claim to a patent monopoly, sufficiently extensive to cover the whole application of steam to the impelling of vessels on water; for less would hardly justify so expensive an experiment.

12thly. A patent may be set aside by scire facias, or stopt in limine by caveat; but as in England every person takes out a patent at his own risk, and on his own responsibility, the usual course is, that persons willing to contest the patent right, use the invention and leave the patentee to his remedy at law. This remedy is an action on the case against the person infringing the patent right. The declaration should set forth the invention in general terms, the patent, the specification duly enrolled, with averments

that it is a new manufacture (a word to which great latitude of construction is given) not used before within the realm of England, that the patentee is the first inventor or introducer, that the invention is not contrary to law, or mischievous to the state, or hurtful to trade, or generally inconvenient (following the statute) and that the defendant at a certain time and place fraudulently used or imitated the same in whole or in part, as the case may be, to the damage of the plaintiff.

13thly. Injunction will be granted against persons infringing a patent right, until the right be tried in a court of law; even in the face of strong objections to the specification. Haymer v. Plane, 14 Vez. 130. Boulton and Watt v. Bull, 3 Vez. 140. Indeed, the rule is, that persons in possession are entitled to injunction, which the court may grant either on terms or without.

Such are the leading cases and points on the subject of Patent rights in England: including, as it seems to me, some useful and important principles.

The laws of *this country* upon the subject are as follow. I copy Graydon's Digest, title PATENTS.

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ACT of February 21, 1793. (Vol. II. p. 200.)

1. SECT. I. When any person or persons being a citizen or citizens of the United States, shall allege that he or they have invented any new and useful art, machine, manufacture or composition of matter, or any new and useful improvement on any art, machine, manufacture or composition of matter, not known or used before the application, and shall present a petition to the se-

cretary of state, signifying a desire of obtaining an exclusive property in the same, and praying that a patent may be granted therefor, it shall and may be lawful for the said secretary of state, to cause letters patent to be made out in the name of the United States, bearing test by the president of the United States, reciting the allegations and suggestions of the said petition, and giving a short description of the said invention or discovery, and thereupon granting to such petitioner, or petitioners, his, her or their heirs, administrators or assigns, for a term not exceeding fourteen years, the full and exclusive right and liberty of making, constructing, using and vending to others to be used, the said invention or discovery, which letters patent shall be delivered to the attorney general of the United States, to be examined; who, within fifteen days after such delivery, if he finds the same conformable to this act, shall certify accordingly at the foot thereof, and return the same to the secretary of state, who shall present the letters patent thus certified, to be signed, and shall cause the seal of the United States to be thereto affixed: And the same shall be good and available to the grantee or grantees, by force of this act, and shall be recorded in a book, to be kept for that purpose, in the office of the secretary of state, and delivered to the patentee or his order. [See *postea* 10.]

2. Sect. II. *Provided always*, That any person, who shall have discovered an improvement in the principle of any machine, or in the process of any composition of matter, which shall have been patented, and shall have obtained a patent for such improvement, he shall not be at liberty to make, use or vend the original discovery, nor shall the first inventor be at liberty to use the improvement: And it is hereby enacted and declared, that simply changing the form or the proportions of any machine, or composition of matter, in any degree, shall not be deemed a discovery.

3. Sect. III. Every inventor, before he can receive a patent, shall swear or affirm, that he does verily believe, that he is the true inventor or discoverer of the art, machine, or improvement, for which he solicits a patent; which oath or affirmation may be made before any person authorized to administer oaths, and shall deliver a written description of his invention, and of the manner of using, or process of compounding the same, in such full, clear and exact terms, as to distinguish the same from all other things before known, and to enable any person skilled in the art or science, of which it is a branch, or with which it is most nearly connected, to make, compound, and use the same. And in the case

of any machine, he shall fully explain the principle, and the several modes, in which he has contemplated the application of that principle or character, by which it may be distinguished from other inventions; and he shall accompany the whole with drawings and written references, where the nature of the case admits of drawings, or with specimens of the ingredients, and of the composition of matter, sufficient in quantity for the purpose of experiment, where the invention is of a composition of matter: which description, signed by himself, and attested by two witnesses, shall be filed in the office of the secretary of state, and certified copies thereof shall be competent evidence, in all courts, where any matter or thing, touching such patent right, shall come in question. And such inventor shall, moreover, deliver a model of his machine, provided the secretary shall deem such model to be necessary.

4. SECT. IV. It shall be lawful for any inventor, his executor or administrator, to assign the title and interest in the said invention, at any time, and the assignee having recorded the said assignment, in the office of the secretary of state, shall thereafter stand in the place of the original inventor, both as to right and responsibility, and so the assignees of assigns, to any degree.

SECT. V. *is repealed and supplied.* [See *postea* 12.]

5. SECT. VI. *Provided always*, That the defendant in such action shall be permitted to plead the general issue, and give this act and any special matter, of which notice in writing may have been given to the plaintiff or his attorney, thirty days before trial, in evidence, tending to prove, that the specification, filed by the plaintiff, does not contain the whole truth relative to his discovery, or that it contains more than is necessary to produce the described effect, which concealment or addition shall fully appear to have been made, for the purpose of deceiving the public, or that the thing, thus secured by patent, was not originally discovered by the patentee, but had been in use, or had been described in some public work, anterior to the supposed discovery of the patentee, or that he had surreptitiously obtained a patent for the discovery of another person: In either of which cases, judgment shall be rendered for the defendant, with costs, and the patent shall be declared void.

6. SECT. VII. Where any state before its adoption of the present form of government, shall have granted an exclusive right to any invention, the party claiming that right, shall not be capable of obtaining an exclusive right under this act, but on relinquishing his right, under such particular state, and of such relinquish-

ment, his obtaining an exclusive right under this act shall be sufficient evidence.

SECT. VIII. *is obsolete.*

7. SECT. IX. In case of interfering applications, the same shall be submitted to the arbitration of three persons, one of whom shall be chosen by each of the applicants, and the third person shall be appointed by the secretary of state: And the decision or award of such arbitrators, delivered to the secretary of state, in writing and subscribed by them, or any two of them, shall be final, as far as respects the granting of the patent; And if either of the applicants shall refuse or fail to choose an arbitrator, the patent shall issue to the opposite party. And where there shall be more than two interfering applications, and the parties applying shall not all unite in appointing three arbitrators, it shall be in the power of the secretary of state to appoint three arbitrators for the purpose.

8. SECT. X. Upon oath or affirmation being made, before the judge of the district court, where the patentee, his executors, administrators or assigns reside, that any patent, which shall be issued in pursuance of this act, was obtained surreptitiously, or upon false suggestion, and motion made to the said court, within three years after issuing the said patent, but not afterwards, it shall and may be lawful for the judge of the said district court, if the matter alleged shall appear to him to be sufficient, to grant a rule, that the patentee, or his executor, administrator or assign, shew cause, why procees should not issue against him to repeal such patent. And if sufficient cause shall not be shewn to the contrary, the rule shall be made absolute, and thereupon the said judge shall order process to be issued against such patentee, or his executors, administrators or assigns, with costs of suit. And in case, no sufficient cause shall be shewn to the contrary, or if it shall appear, that the patentee was not the true inventor or discoverer, judgment shall be rendered by such court for the repeal of such patent; and if the party, at whose complaint the process issued, shall have judgment given against him, he shall pay all such costs, as the defendant shall be put to, in defending the suit, to be taxed by the court, and recovered in due course of law.

9. SECT. XI. Every inventor, before he presents his petition to the secretary of state, signifying his desire of obtaining a patent, shall pay into the treasury thirty dollars, for which he shall take duplicate receipts; one of which receipts he shall deliver to the secretary of state, when he presents his petition: And the money,

thus paid, shall be in full for the sundry services, to be performed in the office of the secretary of state, consequent on such petition, and shall pass to the account of clerk-hire in that office. *Provided nevertheless*, That for every copy, which may be required at the said office, of any paper respecting any patent, that has been granted, the person obtaining such copy, shall pay at the rate of twenty cents, for every copy-sheet of one hundred words, and for every copy of a drawing, the party obtaining the same, shall pay two dollars: Of which payments, an account shall be rendered, annually, to the treasury of the United States, and they shall also pass to the account of clerk-hire, in the office of the secretary of state.

SECT. XII. *repeals the act passed April* 10, 1790, (Vol. I. p. 99,) *with the proviso*, That nothing, contained in this act, shall be construed to invalidate any patent, that may have been granted under the authority of the said act; and all patentees under the said act, their executors, administrators and assigns, shall be considered within the purview of this act, in respect to the violation of their rights: Provided, such violation shall be committed, after the passing of this act.

ACT of April 17, 1800. (Vol. V. p. 88.)

10. SECT, I. All and singular the rights and privileges given, intended or provided to citizens of the United States, respecting patents, for new inventions, discoveries, and improvements, by the act entitled "An act to promote the progress of useful arts, and to repeal the act heretofore made for that purpose," shall be, and hereby are extended and given to all aliens who at the time of petitioning in the manner prescribed by the said act, shall have resided for two years within the United States, which privileges shall be obtained, used, and enjoyed, by such persons, in as full and ample manner, and under the same conditions, limitations and restrictions, as by the said act is provided and directed in the case of citizens of the United States. *Provided always*, That every person petitioning for a patent for any invention, art or discovery, pursuant to this act, shall make oath or affirmation before some person duly authorized to administer oaths, before such patent shall be granted, that such invention, art or discovery hath not, to the best of his or her knowledge or belief, been known or used either in this or any foreign country; and that every patent which shall be obtained pursuant to this act, for any invention, art or discovery, which it shall afterwards appear had been known or used pre-

vious to such application for a patent, shall be utterly void. [See *antea* 1.]

11. SECT. II. Where any person hath made, or shall have made, any new invention, discovery or improvement, on account of which a patent might, by virtue of this or the abovementioned act, be granted to such person, and shall die before any patent shall be granted therefor, the right of applying for and obtaining such patent, shall devolve on the legal representatives of such person in trust for the heirs at law of the deceased, in case he shall have died intestate; but if otherwise, then in trust for his devisees, in as full and ample manner, and under the same conditions, limitations and restrictions, as the same was held or might have been claimed or enjoyed by such person, in his or her lifetime; and when application for a patent shall be made by such legal representatives, the oath or affirmation, provided in the third section of the beforementioned act, shall be so varied as to be applicable to them. [See *antea* 3.]

12. SECT. III. Where any patent shall be, or shall have been granted pursuant to this or the abovementioned act, and any person without the consent of the patentee, his or her executors, administrators or assigns first obtained in writing, shall make, devise, use, or sell the thing whereof the exclusive right is secured to the said patentee by such patent, such person so offending shall forfeit and pay to the said patentee, his executors, administrators or assigns, a sum equal to three times the actual damage sustained by such patentee, his executors, administrators or assigns, from or by reason of such offence, which sum shall and may be recovered, by action on the case founded on this and the abovementioned act, in the circuit court of the United States, having jurisdiction thereof.

SECT. IV. *is a repealing clause.*

So far the acts of our country.

In the case of Parsons v. Barnard and Parsons v. Wigton, 7 Johnson's Rep. 144, it was determined that the state courts have no jurisdiction in suits on patents: a determination clearly right in point of law, but pregnant with many inconveniences, and a source of numerous and vexatious impositions: for manufacturers at a distance from the metropolis of a state, are strongly deterred by calculations of prudence, from contesting a right at quadruple the expence they can compromise the demand. I am fully aware on the other hand, of the hardship of dragging a patentee and his

witnesses into every petty court of the United States; still the case requires a remedy, or patents will become a public evil of no slight magnitude.

Some north-eastern speculator, I heard of lately, procured or pretended to have procured, a patent right for using stone coal in a blacksmith's forge: on being taxed with the strangeness and uselessness of such a patent, he replied "no matter: it will be worth "while for every blacksmith to give me a couple of dollars for a "right rather than contest it with me." It has proved a good speculation. I wish it were the only successful case of contributions levied on the public, by the bold speculations of patentees.

I do not know of any other than two cases decided on patents in our American courts.

The first case is the contested right of Messrs. Livington and Fulton, against Van Ingen and others to an exclusive privilege in New York state for the use of their steam boat, decided in 1812.

By several acts of the assembly of New York state, an exclusive right was granted to Livingston and Fulton, to navigate the waters of that state by means of vessels propelled by steam. It appears that the appellants, Livingston and Fulton, did not arrogate to themselves the invention of the steam engine employed, or the means and method of applying it, so as to propel the vessels; they claimed merely to be the *possessors* of a method of applying the steam engine to propel a boat on new and advantageous principles. Fitch's grant to navigate by steam, stood in the way; but as Fitch had never made any attempt during ten years to put in execution his method of navigating by steam, it was (in my opinion rightly) considered as renounced and abandoned. This case is reported in 9 Johnson's Rep. 507, and Halls law Journal, V. 4. p. 169.

Livingston and Fulton applied to the court of chancery for an injunction, against Van Ingen, which was denied by Chancellor Lansing, whose opinion was revised on error and overruled. I think rightly.

The objections were principally, 1st. That the monopoly granted by the state legislature of New York, was an infringement on the exclusive right of congress to grant patents. 2ly. That they infringed on the exclusive right of congress to regulate commerce. 3ly. That the injunction ought not to be granted, inasmuch as the legislative acts had provided a remedy which the patentees were limited to pursue.

The reply to the first ground was, that the powers of congress were to be construed strictly: they had power to grant patents to

inventors only. This was not pretended to be an invention; the appellants were possessors only of a new and advantageous me-method; but it was the introduction of an improvement of so much importance, as fully to justify the bargain made by the legislature on behalf of the public with the appellants, Livingston and Fulton. It had been fully settled in England, that the *introducers* of inventions and improvements, were entitled to patent rights. 2ly. The power of granting patents was not of an exclusive, but a concurrent nature.

As to the second ground, it was said, that this was no more regulating commerce, than laws concerning ferries or stage coaches could be said to be so. This had nothing to do with exports or imports.

As to the third ground, it was shewn to be the usual course, for the court of chancery to grant injunctions in favour of persons in the actual possession of rights; sometimes without, sometimes upon terms of speedy trial of the right at law. The appellants Fulton and Livingston succeeded.

In this case, the state allowed some years to enable the applicants to bring to perfection, and into actual use, their contemplated improvement: an allowance, which the magnitude of the undertaking well deserved.

The other case was decided in Feb. 1813, by judges Duvall and Houston, of Maryland, in favour of Oliver Evans against some millers near Baltimore. I have not seen a report of the case, but I understand that the point decided was this. Oliver Evans's patent for his elevators was declared illegal. He applied for an extension of his term of monopoly, and obtained it. In the interval, after the annulling of his first patent, and previous to obtaining his second, while the invention (if it was one) was open to all the world, some millers had put up machines of the nature of his elevators. On obtaining his second patent, he brought suit against them; and the court charged the jury, that the defendants were liable to pay for these machines, erected when no law forbad their erection, and no patent stood in the way of their use. A decision so dubious, that I much wonder at the acquiescence of the defendants under it. I have understood that a similar decision was made by judge Washington and judge Peters in Philadelphia. I greatly respect all these gentlemen: still, the decision appears to me a very strange one.

Such is the *law* on the subject so far as I can briefly trace it.

The following letter of Mr. Jefferson, contains so much matter worthy of consideration as to patent rights, that I think it worth while to subjoin it, without interfering any way, or giving any opinion as to the collateral question of Mr. Oliver Evans's patents. It appears to have been written in consequence of a request made to Mr. Jefferson, to give his sentiments on the validity of Mr. Evans's claim. I copy it from Niles's Register, addenda to the 5th volume.

Monticello, August 13th, 1813.

SIR,

Your letter of August 3d, asking information on the subject of Mr. Oliver Evans's exclusive right to the use of what he calls his Elevators, Conveyers and Hopperboys, has been duly received. My wish to see new inventions encouraged, and old ones brought again into useful notice, has made me regret the circumstances which have followed the expiration of his first patent. I did not expect the retrospection which has been given to the reviving law; for although the second proviso seemed not so clear as it ought to have been, yet it appeared susceptible of a just construction; and the retrospective one being contrary to natural right, it was understood to be a rule of law, that where the words of a statute admit of two constructions, the one just and the other unjust, the former is to be given them. The first proviso takes care of those who had lawfully used Evans' improvements under the first patent; the second was meant for those who had lawfully erected and used them after that patent expired, declaring they "should not be liable to damages therefor." These words may indeed be restrained to uses already past; but as there is parity of reason for those to come, there should be parity of law. Every man should be protected in his lawful acts, and be certain that no ex post facto law shall punish or endamage him for them. But he is endamaged if forbidden to use a machine lawfully erected at considerable expense, unless he will pay a new and unexpected price for it. The proviso says, that he who erected and used lawfully shall not be liable to pay damages: but if the proviso had been omitted would not the law, construed by natural equity, have said the same thing? In truth both provisos are useless. And shall useless provisos, inserted pro majori cautela, only authorise inferences against justice? The sentiment that ex post facto laws are against natural rights is so strong in the United States, that few, if any, of the state constitutions have failed to proscribe them. The federal con-

stitution indeed interdicts them in criminal cases only; but they are equally unjust in civil as in criminal cases: and the omission of a caution which would have been right, does not justify the doing what is wrong; nor ought it to be presumed, that the legislature meant to use a phrase in an unjustifiable sense, if by any rules of construction it can be even strained to what is just. The law books abound with similar instances of the care the judges take of the public integrity. Laws moreover abridging the natural rights of the citizen, should be restrained by rigorous constructions within their narrowest limits.

Your letter, however, points to a much broader question, whether what have received from Mr. Evans the new and the proper name of Elevators are of his invention: because, if they are not, his patent gives him no right to obstruct others in the use of what they possessed before. I assume it as a lemma, that it is the invention of the machine itself which is to give a patent right, and not the application of it to any particular purpose of which it is susceptible. If one person invents a knife convenient for pointing our pens, another cannot have a patent right for the same knife to point our pencils. A compass was invented for navigating the sea; another could not have a patent right for using it to survey land. A machine for threshing *wheat* has been invented in Scotland; a second person cannot get a patent right for the same machine to thresh *oats;* a third *rye;* a fourth *peas;* a fifth *clover*, &c. A string of buckets is invented and used for raising water, ore, &c. can a second have a patent right to the same machine for raising wheat, a third oats, a fourth rye, a fifth peas, &c.? The question then whether such a string of buckets was invented first by Oliver Evans, is a mere question of fact in mathematical history. Now turning to such books only as I happen to possess, I find abundant proof that this simple machinery has been in use from time immemorial. Doctor Shaw, who visited Egypt and the Barbary coast, in the years 1727—8, 9, in the margin of his map of Egypt, gives us the figure of what he calls a Persian wheel, which is a string of round cups, or buckets, hanging on a pully, over which they revolve, bringing up water from a well, and delivering it into a trough above. He found this used at Cairo, in a well 264 feet deep, which the inhabitants believe to have been a work of the patriarch Joseph. Shaw's Travels, 341, Oxford edition of 1738, in folio, and the Universal History, I. 416, speaking of the manner of watering the high lands in Egypt, says—"Formerly they made use of Archi-

medes' Screw, thence named the Egyptian Pump; but they now generally use Wheels (Wallowers) which carry a rope or chain of earthen pots, holding about 7 or 8 quarts a piece, and draw the water from the canals. There are besides, a vast number of wells in Egypt, from which the water is drawn in the same manner to water the gardens and fruit trees; so that it is no exaggeration to say, that there are in Egypt above 200,000 oxen daily employed in this labour." Shaw's name of Persian wheel has been since given more particularly to a wheel with buckets, either fixed or suspended on pins at its periphery.—Mortimer's Husbandry, 1, 18, Duhamel, V. Ferguson's Mechanics, plate 13. But his figure, and the verbal description of the Universal History, prove, that the string of buckets is meant under that name. His figure differs from Evans' construction in the circumstances of the buckets being round, and strung through their bottom on a chain; but it is the principle; to wit, a string of buckets, which constitutes the invention, not the form of the buckets, round, square, or hexagon; nor the manner of attaching them, nor the material of the connecting band, whether chain, rope or leather. Vitruvius, L. X. c. 9, describes this machinery as a windlass, on which is a chain descending to the water, with vessels of copper attached to it; the windlass being turned, the chain moving on it will raise the vessels, which in passing over the windlass, will empty the water they have brought up into a reservoir: and Perrault, in his edition of Vitruvius, Paris, 1784, folio, plates, 61, 62, gives us three forms of these water elevators, in one of which the buckets are square, as Mr. Evans' are. Bossut, Histoire des Mathematiques, I. 86, says, "The drum wheel, the wheel with buckets, and the *chapelets*, are hydraulic machines, which come to us from the ancients; but we are ignorant of the time when they began to be put into use." The *chapelets* are the revolving band of buckets, which Shaw calls the Persian wheel, the moderns a chain pump, and Mr. Evans elevators. The next of my books, in which I find these elevators, is Wolf's Cours de Mathematiques, I. 370, and plate 1, Paris, 1747—8vo. Here are two forms; in one of them the buckets are square, attached to two chains, passing over a cylinder or wallower at top, and under another at bottom, by which they are made to revolve. It is a nearly exact representation of Evans' elevators. But a more exact one is to be seen in Desagulier's Experimental Philosophy, II. plate 34. In the Encyclopedie de Diderot et D'Alembert, 8vo. edition de Lausanne, 1st vol. of plates, in the four subscribed "Hy-

draulique, noria," is one, where round earthen pots are tied by their collars, between two endless ropes, suspended on a revolving lanthern or wallower; this is said to have been used for raising ore out of a mine. In a book which I do not possess, "L'Architecture Hydraulique de Belidor, the II vol. of which is said [De La Lande's continuation of Montucla's Histoire des Mathematiques, III. 711] to contain a detail of all the pumps, ancient and modern, hydraulic machines, fountains, wells, &c. I have no doubt this Persian wheel, chain pump, chapelets, elevators, by whichever name you choose to call it, will be found in various forms. The last book I have to quote for it is Proney's Architecture Hydraulique, I. advertisement VII. and sec's 648, 649, in the latter of which passages he observes, that the first idea which occurs for raising water is to lift it in a bucket by hand; when the water lies too deep to be reached by hand, the bucket is suspended by a chain and let down over a pully or windlass; if it be desired to raise a continued stream of water, the simplest means which offers itself to the mind is to attach to an endless chain or cork a number of pots or buckets, so disposed that the chain being suspended on a lanthern or wallower above, and plunged in water below, the buckets may descend and ascend alternately, filling themselves at bottom, and emptying at a certain height above, so as to give a constant stream. Some years before the date of Mr. Evans' patent, a Mr. Martin of Caroline county, in this state, constructed a drill plough, in which he used the band of buckets for elevating the grain from the box, into the funnel which let them down into the furrows: he had bands with different setts of buckets, adapted to the size of peas, of turnip seed, &c. I have used this machine for sowing benni seed also, and propose to have a band of buckets for drilling Indian corn, and another for wheat. Is it possible that in doing this I shall infringe Mr. Evans' patent? That I can be debarred of any use to which I might have applied my drill when I bought it, by a patent issued after I bought it.

These verbal descriptions applying so exactly to Mr. Evans' Elevators, and the drawings exhibited to the eye, flash conviction both on reason and the senses that there is nothing new in these elevators but their being strung together by a strap of leather. If this strap of leather be an invention entitling the inventor to a patent right, it can only extend to the strap, and the use of the string of buckets must remain free to be connected by chains, ropes, a

strap of hempen girthing, or any other substance except leather; but indeed Mr. Martin had before used the strap of leather.

The screw of Archimedes is as ancient at least as the age of that mathematician, who died more than 2000 years ago. Diodorus Siculus speaks of it, lib. 1, page 21, and lib. 5, page 217, of Stevens' edition of 1559, folio, and Vitruvius, X. 11. The cutting of its spiral worm into sections, for conveying flour or grain, seems to have been an invention of Mr. Evans', and to be a fair subject of a patent right, but it cannot take away from others the use of Archimedes' screw, with its perpetual spiral, for any purposes of which it is susceptible.

The Hopperboy is an useful machine and as far as I know original.

It has been pretended by some (and in England especially) that inventors have a natural and exclusive right to their inventions; and not merely for their own lives, but inheritable to their heirs: but while it is a moot question, whether the origin of any kind of property is derived from nature at all, it would be singular to admit a natural and even an hereditary right to inventions. It is agreed by those who have seriously considered the subject, that no individual has, of natural right, a separate property in an acre of land: for instance, by an universal law, indeed, whatever, whether fixed or moveable, belongs to all men equally and in common, is the property for the moment of him who occupies it; but when he relinquishes the occupation the property goes with it. Stable ownership is the gift of social law, and is given late in the progress of society: it would be curious then if an idea, the fugitive fermentation of an individual brain, could of natural right be claimed in exclusive and stable property. If nature has made any one thing less susceptible than all others of exclusive property, it is the action of the thinking power called an idea; which an individual may exclusively possess as long as he keeps it to himself, but the moment it is divulged, it forces itself into the possession of every one, and the receiver cannot dispossess himself of it. Its peculiar character too is that no one possesses the less because every other possesses the whole of it. He who receives an idea from me receives instruction himself without lessening mine; as he who lights his taper at mine receives light without darkening me. That ideas should freely spread from one to another over the globe for the moral and mutual instruction of man and improvement of his conditions, seems to have been peculiarly and benevolently

designed by nature when she made them, like fire, expansible over all space, without lessening their density in any point; and like the air in which we breathe, move, and have our physical being, incapable of confinement or exclusive appropriation. Inventions then cannot in nature be a subject of property. Society may give an exclusive right to the profits arising from them as an encouragement to men to pursue ideas which may produce utility. But this may or may not be done according to the will and convenience of the society, without claim or complaint from any body. Accordingly it is a fact, as far as I am informed, that England was, until we copied her, the only country on earth which ever by a general law gave a legal right to the exclusive use of an idea. In some other countries it is sometimes done in a great case and by a special and personal act; but generally speaking other nations have thought that these monopolies produce more embarrassment than advantage to society; and it may be observed that the nations which refuse monopolies of inventions are as fruitful as England in new and useful devices.*

Considering the exclusive right to invention as given, not of natural right, but for the benefit of society, I know well the difficulty of drawing a line between the things which are worth to the public the embarrassment of an exclusive patent and those which are not. As a member of the patent board for several years, while the law authorised a board to grant or refuse patents, I saw with what slow progress a system of general rules could be matured. Some however were established by that board. One of these was, that a machine of which we were possessed, might be applied by every man to any use of which it is susceptible, and that this right ought not to be taken from him and given to a monopolist, because he first, perhaps, had occasion so to apply it. Thus a screw for crushing plaister might be employed for crushing corn cobs; and a chain pump for raising water might be used for raising wheat—this being merely a change of application. Another rule was, that a change of material, should not give title to a patent; as the making a plough share of cast rather than wrought iron; a comb of iron instead of horn or of ivory; or the connecting of buckets by a band of leather rather than of hemp or iron. A third was, that a mere change of form, should give no

* I doubt this. The brevet d'invention, was a patent right in France, if I do not mistake; though I do not find it in the Code of the year 1804. T. C.

right to a patent; as a high quartered shoe instead of a low one, a round hat instead of a three square, or a square bucket instead of a round one; but for this rule, all the changes of fashion in dress, would have been under the tax of patentees. These were among the rules which the uniform decisions of the board had already established: and under each of them Mr. Evans' patent would have been refused. 1st, Because it was a mere change of application of the chain pump from raising water, to raise wheat. 2d, Because the using a leathern instead of a hempen band, was a mere change of material: and 3rdly, square buckets instead of round, are only a change of form; and the ancient forms too, appear to have been indifferently square or round. But there were still abundance of cases which could not be brought under rule, until they should have presented themselves under all their aspects; and these investigations occupying more time of the members of the board, than they could spare from higher duties, the whole was turned over to the judiciary, to be matured in a system under which every one might know when his actions were safe and lawful. Instead of refusing a patent in the first instance, as the board was authorised to do, the patent now issues of course subject to be declared void on such principles as should be established by the courts of law. This business however is but little analogous to their course of reading, since we might in vain turn over all the lubberly volumes of the law, to find a single ray which would lighten the path of the mechanic or mathematician; it is more within the information of a board of academical professors, and a previous refusal of a patent would better guard our citizens against harrassment by law suits. But England had given it to her judges, and the usual predominancy of her examples, carried it to ours.

It happened that I had myself a mill built in the interval between Mr. Evans's first and second patents. I was living in Washington, and left the construction of the mill entirely to the millwright. I did not even know he had erected elevators, conveyors and hopperboys, until I learnt it by an application, from Mr. Evans's agent for the patent price. Although I had no idea he had a right to it by law (for no judicial decision had then been given) yet I did not hesitate to remit to Mr. Evans the old and moderate patent price, which was what he then asked, from a wish to encourage even the useful revival of ancient inventions. But I then expressed my opinion of the law, in a letter either to Mr. Evans or to his agent.

I have thus, sir, at your request given you the facts and ideas which occur to me on the subject. I have done it without reserve, although I have not the pleasure of knowing you personally. In thus frankly committing myself to you, I trust you will feel it as a point of honour and candour to make no use of my letter, which might bring disquietude on myself;* and particularly I should be unwilling to be brought into any difference with Mr. Evans, whom, however, I believe too reasonable to take offence at an honest difference of opinion. I esteem him much, and sincerely wish him wealth and honour. I deem him a valuable citizen of uncommon ingenuity and usefulness; and had I not esteemed still more the establishment of sound principles, I should now have been silent. If any of the matter I have offered can promote that object, I have no objection to its being so used. If it offers nothing new, it will of course not be used at all.

I have gone with some minuteness into the mathematical history of the elevator, because it belongs to a branch of science, in which, as I have before observed, it is not incumbent on lawyers to be learned; and it is possible, therefore, that some of the proofs I have quoted, may have escaped on their former arguments.

On the law of the subject I should not have touched, because more familiar to those who have already discussed it, but I wished to state my own view of it merely in justification of myself; my name and approbation being subscribed to the act. With these explanations accept the assurances of my respect.

TH: JEFFERSON.

I have looked into the Code Napoleon of the year 14, for the law of France relating to Brevets d'invention, and into the published speeches of orators on that code, but I cannot find any thing on the subject.

Having now given all the information I am in possession of, as to the existing circumstances of patent rights, I shall offer my own suggestions on this difficult and interesting subject.

And First, I would premise, that although I do not consider persons whose time is so exclusively dedicated to legal discussions as the gentlemen of the profession in England, and indeed in this country, as fully competent to decide all the questions that can

* It is proper to observe, that though the author did not at the time writing this letter, contemplate its publication, yet his permission has since been obtained.

arise upon patents; yet I would by no means exclude the lights to be derived from a court of law. I think the preceding summary of decisions will shew, that much good sense, in the decision, has been the result of much and patient reflection in considering the subject of patent rights in England. Nor can we well dispense with the accuracy and precision of a court of law.

But in the case of Liardet and Johnson which I remember; in the case of Turner against Winter, reported; in the case of Oliver Evans at Baltimore; in the case of Livingston and Fulton against Van Ingen, before chancellor Lansing, notwithstanding the known abilities of the judges, a scientific man cannot but feel the want of scientific knowledge in the bench and the bar; and the narrow views taken of the subjects discussed. Yet more able men in their own profession, are not easily found.

I can well remember being sent up by a committee of manufacturers from Manchester, to oppose a patent for bleaching with oxymuriatic acid founded upon Berthollet's process. The question was heard before Macdonald, master of the rolls at his chambers: Graham was employed by the applicant for the patent, who hearing the torrent of voluble but unintelligible declamation uttered by his counsel, quitted the room in disgust, and left the master of the rolls to decide according to the best of his comprehension: who certainly did not understand one syllable of what was spoken, any more than the speaker.

Hence, secondly, I would propose a board of scientific men, to whom should be submitted, in the first instance, all applications for patents. Should they reject the application, let the applicant nevertheless take out his patent at his own risk; but accompanied with the reasons of the board for rejecting it; which reasons should be evidence for the consideration of a court and jury, in case the claim should be contested; and double costs awarded in all cases of final judgment against the patentee of an application thus rejected.

Thirdly, some provision should be made, to promulgate the patents taken out, at present, the specifications are as utterly unknown to the public at large, as if they had been filed only among the records of China. The office is useless: who but Dr. Thornton knows what it contains? And it is greatly to be doubted whether that gentleman, intelligent as he is, be much the wiser for the records of his office, for I do not know that it is his business to be so. At any rate, the public are not. Suppose, a volume

every year, or oftener if need be, were published under the direction of the board, of the specifications and plates filed in the office—the sale would bear the expence: if not, raise the fees on issuing patents to cover the cost of publication. If this were done, the public might stand the chance of knowing a little of what is going forward in the patent office, and be somewhat the wiser for the discoveries of individuals: at present they know nothing; and patents are taken out by persons who may innocently infringe upon the discoveries of others.

Fourthly. The exclusive jurisdiction of the courts of the United States, gives rise to vexatious levies on the community. It is worth no man's while in the back country of any state, to resist a claim of 2 or 300 dollars, however unfounded, if he is to be dragged to the metropolis, court after court, to encounter an adversary, whose interest it is to render such a suit, by delays and removals, too expensive to be continued; and to bear down opposition, by the trouble and the cost attending upon it.

The remedy is difficult to be suggested; but I should suppose, that it would sufficiently guard the patentee against vexatious contests, if after one decision in any court of a state in his favour on the point in contest, he should be entitled, on producing the record, to double costs in every other suit on the same point, tried in the same state, wherein final judgment should be passed in his favour. In all suits brought by the patentee, every person interested ought to be allowed to become joint defendant, on motion after notice.

Such are my present opinions, which I throw out for public consideration. T. C.

COOKERY.

Cum labor extuderit fastidia, siccus, inanis,
Sperne cibum vilem: nisi Hymettia mella Falerno
Ne biberis diluta. Foris est Promus; et atrum
Defendens pisces hiemat mare: cum sale panis
Latrantem stomachum bene leniet. Unde putas aut
Qui partum? Non in caro nidore voluptas
Summa, sed in te ipso est. Tu pulmentaria quære
Sudando. Pinguem vitiis, albumque, nec ostrea
Nec scarus, aut poterit peregrina juvare Lagois.
Hor. Stat. 2.

THE art of cookery, is or ought to be employed for the purpose of rendering human food, 1st, more digestible. 2dly, more palatable. 3dly, to extract the greatest quantity of nutriment from a given quantity of food. 4thly, to ascertain what articles of food best combine the qualities of cheapness, pleasantness, wholesomeness, nutrition, and easy cookery. Under this view of the subject I shall offer to your consideration, my good friend, in the first place, what occurs to me on the Economy of cookery, and the principles that belong to the *Culina Pauperum*, and perhaps we may strike out something that even the rich may not despise. Something like this has been done by the Pharmacopæia Pauperum* of the British medical school, which under the notion of killing or curing the poor at a trifling expence, has introduced many valuable remedies. The use of the cold bath so much more extensively than heretofore, the use of Fowler's ague drop, and the substitution of oak bark and gentian for the Jesuit's bark, are among the truly valuable improvements.

You will say the poor do not read the Emporium: neither do they read Horace or Count Rumford: though I do almost think they would be almost as well employed in studying Rumford's essays on cookery, or Barlow's poem on hasty pudding, as Barlow's advice to the privileged orders, or his Conspiracy of Kings. But improvements in the condition of the poor, must be derived from knowledge communicated by those who are not poor. The poor have no time to think for themselves: unluckily the course of human affairs requires (less indeed in this country than else-

* I do not know of any regular Pharmacopæia under that name; but there is such a system in practice.

where) that their time shall be occupied in the labour of the body so much, as almost to exclude the labour of the mind.

But it may serve an useful purpose to consider the subject on *principle.*

The distinctive characters of a poor man's kitchen and a rich man's kitchen are these:

The aim of the poor man is to satisfy the cravings of *hunger* at the cheapest rate, at the least expence of food.

The aim of the rich man is to indulge the cravings of the *palate*, so that he may consume as much food pleasurably, as a due regard to health will permit.

Hence the poor man should consult in the food he purchases, 1st, cheapness. 2dly, nutriment. 3dly, that kind of food that will most speedily satisfy hunger, and at the same time afford sufficient nutriment.

For like reason, the rich man, would be led to purchase and prepare those articles, of which the greatest quantity can be consumed, consistently with health, previous to the appetite being satisfied: price, being a secondary consideration.

Hence, the provision of the poor should be *insipid*, so that no more food be consumed than the cravings of hunger absolutely require; sapidity incites to the devouring of needless quantity: while the provisions of the rich man, should be *sapid;* and his kitchen and his table abound in condiments.

Count Rumford, therefore, was considerate and humane, but on principle he was wrong, when he recommended hard-baked bread, cut in dices, to be mixed with the soup of the poor—and that it should be flavoured with herring to gratify the palate and prolong the repast. Upon strict principles of economy, there should be no temptation to indulgence beyond what nature absolutely requires. At times when indulgence may be invited, the question is changed: at such times the principles bear upon the cookery of the affluent.

Let us then consider what is the kind of food, that, at the cheapest price, afford most nutriment: and first of vegetables.

Wheat: rye: barley: oats: Indian corn: buckwheat: potatoes: rice.

I will suppose wheat, for instance at Carlisle, at 150 cents. Rye, 100. Barley, 125. Oats, 50. Indian corn, 75. Buckwheat, 75. Potatoes, 50. The wheat will weigh 60lbs. The rye and

barley 56. The oats 36. The Indian corn 56. Potatoes (heaped) 70. Buckwheat about 45.

The nutritious part of grain consists chiefly in the *fecula*, or starch, and the *gluten* it contains: not so much in the mucilage: not at all in the moisture.

Of the above substances, potatoes would be the cheapest, if it were not that the greatest part of their weight is moisture. In Ireland they are cheapest: for in Ireland, Lancashire, and Cheshire, potatoes may be bought at 15 to 20 cents per bushel, heaped. Rice, in a rice country, is the cheapest article of diet, but not here in Pennsylvania. The quantity of actual *nutriment* in the above substances consisting in the greatest proportion of fecula or starch, next of gluten, next of mucilage, would be in this order, viz.

Indian corn: wheat: barley: rye: potatoes: buckwheat: oats.

Their comparative *cheapness* will be, Indian corn: rye: barley: wheat: potatoes: buckwheat. Barley bread is very nearly as good as wheat bread: and abounds in fecula. Hence in Europe its use for beer, in preference to other grain.

It seems clear, that in point of economy, flour should be no further bolted, than to get rid of the husk or bran: if you go farther there is waste. The converting of flour into bread, greatly increases both its digestible and its nutritive qualities, for it is thereby partially decomposed, the farina, the gluten, and the mucilage are more intimately, and, I believe, chemically blended; and the digestive organs have less to do. The bulk also is increased, for 1lb. of fine flour will make more than 1¼lb. of bread. New bread is unwholesome, and is moreover an article of great extravagance; from the temptation to eat more than the calls of mere hunger require. For the purposes of family economy, it should be at least one day old. This fact was well established on the examination of the London bakers before a committee of the house of commons during the scarcity of 1808, 1809.

The toll paid for grinding grain, the trouble of transporting it to and from mill, and the fire employed in baking it, are equivalent, with a poor man, to one fourth of the value. In this respect, potatoes have a decided advantage in countries where fuel is scarce.

Buckwheat and oats appear to have too much husk or bran to put in their claim as cheap articles of diet in this country. Rice in the middle states is too dear. The superiority of Indian

corn, will, I think, be greater in Virginia and thence southward, where this kind of grain is grown to more perfection than wheat; which last is grown to more perfection in the middle states, than corn. Mackenzie in his travels across the American continent, somewhere, I think, says that Indian corn even at 10d. a lb. was the cheapest food they could lay in.

Of the other kinds of vegetables, cabbage, turnips, carrots, parsnips, beets, Jerusalem artichokes, peas, beans, &c. the cheapness depends on the price: and that, from the great imperfection of garden agriculture in this country, is so various in various districts and at various times, that nothing can be said satisfactorily on the subject. The sweeter the vegetable of this description, (as beet, parsnip, carrot) the more nutritive: but turnips *can* be raised and sold so as to afford the greatest quantity of this kind of food for the least price. The Jerusalem artichoke *(Helianthus tuberosus)* which stands the winters of this country admirably, and is very productive, appears to deserve more attention than has yet been bestowed upon it, as food for cattle: and in flavour and consistence, it bears a very close resemblance to the common garden artichoke, *Cynara scolymus.*

Potatoes, turnips, cabbages, and even carrots and beets, can be raised in England where land is dear, so as to be afforded as articles of food for cattle: owing to more labour, more capital, more skill bestowed upon land there. I know of very few places in this country where this can be done, and none where it is done. So true is it that cheapness of food does not depend upon cheapness of land, but on the facility of procuring labour. Provisions are at this moment one fourth cheaper in Paris than at New York, or even at Philadelphia.

Of Animal food. Generally speaking, the price of animal food, is every where double that of bread. In point of nutriment (except in the form of fat) it is twice as dear. Animal food may be considered as consisting of muscular flesh, fat and bone.

Muscular flesh consists of muscular fibre, (fibrin) sparingly soluble in water: of blood vessels, and lymphatic vessels with their contents: and nervous or medullary fibre. The blood contains gelatin, albumen, and the watery part of the serum; I know that Dr. Bostock denies the existence of gelatin, but my observations are not in accord with this. The gelatin is soluble, the albumen is coagulable. That much gelatin is contained in mus-

cular fibre is evident from the strong broth that can be made of it. Beef-tea for instance: while the albumen rises in scum. This broth also contains much of the contents of the lymphatic and the serum, which give flavour: the colouring particles of the blood, remain in the meat.

The fat is insoluble in water, but by means of flour as a *liaison*, may be rendered miscible with water. The use of liaisons, is of equal importance to the poor and the rich, and not well understood by either in this country.

Bones contain much gelatin and marrow, amounting to half their weight, which can be gotten out, by boiling in a pot with a close cover. In common practice you may dissolve one fourth of the weight of the bone.

In boiling, the coagulated albumen separates from the fibrin, and swims in the form of a scum, which is usually thrown away, but it is very nutritive; and by means of flour, as a liaison, can be made miscible with the broth. We regard the scum of a pot as dirt and feculent matter: it is not so, unless where dust has been negligently admitted. The poor therefore should not throw it away.

Of all the parts of an animal, the flesh is the least and the fat the most nutritive.

I think it worth while to detail my reasons at large; or rather my authorities.

1st. In all cold countries, where the climate requires strong food, animal oil is universally resorted to. I instance Kamschatka, Norway, Lapland.

2dly, In all warm countries, where meat is forbidden, either by poverty, by the climate, or by the priesthood, fat is necessary to support muscular strength. Thus in the East Indies among the Hindoos, oil and ghee, are universally used with the rice. In Italy and Spain, among the poor, oil of olive is necessary with their bread, salt, and garlic, where labour is to be performed.

3dly, Among the American Indians, bear's fat and bear's oil are universally held in first rate estimation from one end of the continent to the other. No jerk would support a travelling Indian, unless he had bear's oil to dip it in, or Tossamanonny to eat with it. (Young Indian corn, dried gradually to a chocolate brown, and reduced to a coarse powder.)

4thly, "I experienced," says M. De Pages, (in his travels on the Red river and thence to Natchitoches) "the truth of what is

" said of hunters who live entirely on animal food, but which I " used to find difficult to be believed, namely, that besides their " desiring little nourishment from the leaner part, it soon becomes " offensive to the taste, whereas the fat is both more nutritious, and " continues to be agreeable to the palate.

The late judge Henry in his account of the campaign against Quebec in 1775, p. 46 says, " we feasted till noon, and in the inter- " mediate moments culled the entrails *for the fat.* We broke the " bones and extracted the marrow, under the full persuasion that " *food of an oily nature*, is one of the strongest main stays of hu- " man life. Of this principle if we had a doubt we were shortly " afterwards most irrefragably convinced." Again: " By this " time the fat and marrow of the animals we had killed were ex- " hausted, and our stock of salt expended. One who has never " been deprived of bread and salt, nor known the absence of *oleagi-* " *nous* substances in his food, cannot make a true estimate of the " invaluable benefits of such ingredients in the sustentation of the " bodily frame."

5ly. Every person who has been conversant with Indians, or with the labouring class of people among the whites, or with surveyors who are much in the woods, knows the uniform and universal preference given by them to fat substances as food.

6ly. I know the fact, but I know not now the name of the noble Lord who dining with Mr. Bakewell of Ditchley, the great improver of the breeds of animals, (sheep, oxen and horses) said " Mr. " Bakewell, you improve your sheep to such a degree that they " are too fat to be eatable." " They may be too fat for your Lord- " ship, and the rich class of society; but you form a small part " only of our customers. We breed for the middling classes, and " the poor—for those who eat that they may be enabled to work, " and they know the value of fat, if your Lordship does not."

7ly. Capt. Lewis on his return from his expedition over this continent to the Pacific ocean twice related to me, that when their salt provisions were exhausted, although they sometimes killed deer, yet no quantity that the stomach could bear of the flesh of venison, would enable his people to go through a day's journey without great and exhausting fatigue, sometimes they would eat lean food when they could get it in plenty, from 6 to 7lb. of venison per man; but it did not suffice to sustain the strength of the company. A beaver's tail of a pound or a pound and a half weight, afforded much more nutriment as a meal for two people. All

persons who have eaten this article of food in the woods, speak of it as a great luxury. " An agreable barter ensued (says judge Hen- " ry) we gave salted pork in exchange for two fresh Beaver-tails, " which when boiled, renewed ideas of the May butter of our own " country." p. 23.

Of all meats the bear's meat is the most nutritive: and when not exceeding a year old the most delicious. I mean of meats usuallye aten here. The tail of the beaver, is not usually found in our markets, but bearmeat is; and opossum also is occasionally met with; a very nutritive animal. A bear ham, cured as common gammons are, with salt and salt petre, smoked and dried at my request in Mr. P's family, when dressed, measured six inches of fat, and about $1\frac{1}{2}$ inch of lean. The fat while hot, was so transparent that you might almost read through a slice of it half an inch thick. But the bear was old, and the meat too strong.

Next to bear is pork: the meat universally prefered by hard working people. It was also the food of the Athletæ of old.

Next to pork I should rank beef: and next to beef, mutton. It has been ascertained by direct experiment, that game birds are sooner digested than common meats; and are probably not so nutritive, if we may judge by the analogy of venison. The circumstance related to me by Capt. Lewis, which I have had repeatedly confirmed on other occasions, as to the want of nutriment in venison, explains the reason why venison, and game generally are so fashionable at the tables of the rich: viz. because much of this kind of food can be eaten, without overloading the digestive powers.

These considerations lead us to conclude, that the greatest quantity of nutriment under the least weight, can be put up in the form of bacon fat, moderately salted, to be eaten with tossamanonny, or Indian corn just ripe parched to a light chocolate brown colour, and ground. To make variety, portable soup might be added; which if well seasoned, I think preferable to the salted lean or muscular part of pork. Bread cut in slices and gently baked to a chocolate brown, and then ground, might be substituted; but it is by no means equal weight for weight with parched Indian corn; of which about a handful mixed with water, is a day's meal for an Indian. A small bag of tossamanonny and a bottle of bear's oil, will suffice an Indian for a week's journey.

Were I to recommend the greatest quantity of wholesome nutriment, sufficiently varied not to pall upon the palate, and con-

tained in the smallest compass, I should say that 8 ounces of the fat of well-fed, moderately-salted, well dried pork, two ounces of seasoned portable soup, and 8 ounces of tossamanonny, would be nutriment sufficient to support a day's labour. This would amount to half the usual weight. The stomach requires distention from quantity, as well as mere nutriment; and this is given by the bulk which the parched corn acquires, when mixed with water.*

As to the economical principles of dressing food, they relate 1st. to the economising of the food. 2ly. To the economizing of the fuel.

In 36 Ph. Mag. 142, an account is given of some experiments on a large scale on dressing meat, that seem entitled to full credit.

	lb.	*oz.*	
280lb. of beef lost by boiling in the common way - -	73.	14	or 26½ per cent.
190lb. of beef lost by roasting	61.	2	or 32 per cent.
90lb. of beef lost by baking -	27.	—	or 30 per cent.
Mutton lost by boiling - - -			21⅓ per cent.
Do. by roasting - - -			from 31⅓ to 35½ per cent.

These experiments decide the point, that the cookery of economy, is confined to stewing meat in close vessels; where the liquor in which the meat is boiled, shall be saved, and by the addition of cabbage, carrot, turnip, onion, leek, or all of these, with flour, form a part of the meal. Weight for weight, leek is superior in nutriment and in flavour to onion.

I have mentioned the soup of bones. These should be broken into pieces, and boiled, or rather simmered, in a close vessel. Much nutriment is thrown away in throwing away bones. This has been ascertained on a large scale at Manchester by the gentlemen who superintended the benevolent soup establishments there;

* The common rations of beef delivered to the soldiery, are defective in point of frugality, inasmuch as the bone is always thrown away by the men as useless: whereas bone will yield from 35 to 40 per cent. of very good soup. The camp kettles are ill contrived; they should have covers; which save both time and fuel. Every mess beside a camp kettle should have a thin furnace to economise the fuel used; which is frequently more difficult to be procured than food.

Moreover, lean meat, contains very little nutriment, and hardly any other can be procured on a march. In every point of view therefore, the food for a campaign ought to be previously prepared, where meat of good quality can be procured, and time allowed to prepare it into nutritious food in the smallest compass, and at the cheapest rate.

but I have lost my notes of the particulars. Great benefit in point of nourishment, and improvement in the smoothness of soup, can be derived from linseed, and from gum arabic.

Long continued gentle heat, whether in roasting or boiling (or moderate simmering) renders meat much more tender, juicy, and digestible. A French peasant dines about midday: when his meal is over, he puts into the stew-pan with a close cover, the meat for his next day's dinner; which is exposed to a gentle heat for the 24 hours. A furnace that would hold a gallon of charcoal, and permit the stew-pan to be exposed three-fourths of its depth to the heat of the fire, would be an invaluable present to the poor: and it could be cheaply made at any iron furnace, or any pottery: the common seggar is the thing itself: that is, if it had a rim below to hold the bars for a grate, and a rim above to support the stew-pan. Wood in this country is very dear in the towns, and the extravagance of the back woods is not obliterated in the cities. How often have I seen a quarter of a cord of wood heaped on to boil a teakettle! Such a furnace might be made in a rough way with about five and twenty bricks, so that whatever heat was generated from the fuel, should be applied to the sides of the pot; and this last be protected from the surrounding current of cold air. The inelegance, the inconvenience, the extravagance of an American kitchen is horrible: from the poorest up to the most affluent.

For cookery, whether for the poor or the rich, charcoal at eight dollars the hundred bushels, is cheaper than wood at four dollars a cord. It is more convenient, it is cleaner, it affords the means of expedition, it is more wholesome, it is less fatiguing, it is less hurtful to the eyes. When I come to the kitchen apparatus of a well appointed house, I shall observe further on this.

Sometimes, especially where charcoal is used, it may be a question between saving in point of fuel, and saving in point of food. In some cases of this kind, as where the fuel must be wasted if not used, even broiling may be economical. Generally, however, it may be laid down as an axiom, that where fuel is at a moderate rate, *stewing* is the most frugal, and I believe the most wholesome, and may be made, by far the most palatable method of dressing food.

With respect to *broiling*, or as we term it *barbecueing*, doubtless it is equally extravagant with roasting, so far as the waste of food is concerned; but where the circumstances of fuel admit of it, this method of cooking may occasionally be frugal. In places

where fuel is dear, broiling should be done over a stove supplied with charcoal.

When a poor man purchases meat, the consideration of most moment is not the price per lb., but the relative quantity of meat and bone—next of fat and lean. In point of nutriment, fat is worth twice as much as lean: for candles and soap, thrice as much. Even beef-stakes may be cheaper to a poor man than the cheapest joint of the ox. As to the broiling of a beef-steak, I shall have much to say on the subject when I come to it. For the present, I will only lay down Shakepeare's golden rule; "If when 'twere done, 'twere *well* done, then 'twere well 'twere done *quickly*."

Some experiments have been made by a Mr. W. Scrimshire on the comparative waste in the boiling and roasting of potatoes. Four potatoes were boiled in the usual way, and then steamed to drive off the superfluous water, and render them mealy. They weighed 3562 grains, and lost by the operation when quite cold 80 grains of the original weight, or about two per cent. Another potatoe weighing 1300 grains treated in the same way, lost only 10 grains. The water contained mucilage and extractive matter.

A potatoe of the same kind, weighing 1220 grains, roasted under hot embers, but not sufficiently, lost 200 grains when cold. Another weighing 1198 grains roasted for 1½ hour was found thoroughly cooked, but it had lost when cold 380 grains.

Hence in boiling potatoes, we throw away about 2 per cent. of their weight: in roasting them, about 40 per cent.

The value of the potatoe as an article of culture, is well shewn in the letter of Mr. Curwen, a very spirited and accurate cultivator, and a very well informed and respectable gentleman. I shall subjoin it to this essay, recommending it to the earnest consideration of your readers.

The common breakfast beverage in this country is coffee. I have no hesitation in stating it as a fact, that to a poor family three pounds of dried succory (chicory, chicorium intubus) and one pound of coffee, are of 20 per cent. more value, than four pounds of coffee, and nearly equal in flavour: to me, the beverage is pleasanter. The quantity of the mixture to be used, is about one fourth less than of coffee, to make an infusion of equal strength. Experto crede Roberto. I have frequently drank it. If this be sweetened with molasses made of an inspissated infusion of good malt, it will constitute a saving, that may be an object of some consequence to a poor man with a family. *You* well know that in Northumberland, the poorer people will gladly exchange coffee

for dried chicory, weight for weight. Rye half malted, or even potatoes cut in small pieces, then dried to a chocolate brown, and mixed half and half with coffee, are a pleasant and profitable addition.

The Arabian method of dressing their cuscus-soo, appears to me excellent. In a stew-pan of the size adapted to the family, furnished with a handle that may be taken off at pleasure, to save room in travelling, they put their meat, seasoned with pepper, salt, spices, herbs, sesamum, turmeric, and some rice, with water sufficient to stew it. On the stew-pan, on a rim withinside about an inch below the top edge, rests another stew-pan that fits in close. The bottom of this second or upper stew-pan, is perforated with holes: it is supplied with rice or other vegetables which imbibe and are cooked by the steam of the food below; so that nothing is lost. I do not know a more convenient camp equipage, or a more economical machine for a poor man. I have tried it with full satisfaction.

Good cooking half decomposes, and therefore renders meat more easy of digestion, and of course more nutritious; but this is not *always* an advantage. Labouring people frequently require food that is hard of digestion. It is not an advantage to them that the stomach should be soon empty, or the food pass away too easily. Hence salted meat, and cheese are favourites with them. I have seldom known a delicate female, whose digestion was occasionally bad, and who was occasionally hysterical, that did not require food usually deemed indigestible, such as meat and ham for supper; and with great reverence for the opinions of medical gentlemen, I know of no remedy better for a female, sick headach, or an hysteric fit, than a tumbler full of good hot brandy toddy, with nutmeg and ginger in it. Dr. Cheyne used to say, that a man who had so much regard for his appetite and so little regard for his health, as to eat ham for supper, would not stick to rob on the highway. I do not know that more nonsense has been given to the world in a moderate compass, than by physicians on the article of diet, from the silly remark of Dr. Cheyne, to the grave, common place nonsense of Dr. Willich; whose treatise on diet and regimen, every mistress of a family, ought to consign to her cook to pin on the roasting meat. He deserves a worse family reception, even than Mr. Twiss of notorious memory.

There are some gleams of knowledge in Cullen's Materia Medica, but he theorizes without fact. Whence does he derive his alcalescence of several kinds of meat? He was compelled to say

something, and he said what he could, as learnedly and with as much appearance of scientific theory as he could: but it is very worthless. Darwin knew somewhat about the practical part of eating, and Dr. Sydenham and Dr. Brown (whom I knew in the decline of his life) had discovered from their own feelings, that wine was bad for gout and stone, and that the best beverage was brandy and water. But they were no judges of wine. The common port of an English tavern, is cyder, brandy, elder berries and sloe juice.

But what can, what ought a physician to know profoundly on this subject? Not to speak of some of my living friends to whom the remark will not exactly apply, I should be glad to be informed, what right Dr. Rush, for instance, were he alive, could have to decide on good cookery and good wine? whose hours never his own, could not be encroached upon by the crapulous sensation of too much indulgence! Sober, moderate, abstemious by profession, was *he* equal to give advice on this subject? Those who have been accustomed to good living and indulgence—who occasionally have sojourned amid scanty fare—who have adverted with the attention of a philosopher to the effects on the stomach and the nerves, of good and of bad liquor—who have themselves now and then suffered from occasional excess—and who having lived much in society, have experienced the varieties that plentiful and elegant tables afford—are the only persons qualified to judge. I would rather apply for knowledge of what is wholesome or unwholesome, and what dishes and what wines may be safely indulged in, to the bench of bishops and the bench of judges, to the beneficed clergy and the bar of England, than to the whole host of physicians that the island can muster. I do not like playing with edged tools so near at hand, and therefore I say nothing about the clergy, the bench or the bar of this country.

As to physicians, the clergy of old seem to have been of my opinion, that in cases of intemperance, these gentlemen are not always best qualified to prescribe.

The first case of the gout on record, is related as follows. "And Asa in the thirty and ninth year of his reign was diseased "in his feet, until his disease was exceeding great: yet in his dis- "ease he sought not to the Lord, but to the physicians. So Asa "slept with his fathers, and died in the one and fortieth year of his "reign," &c.

The son of Sirach also, has some queer remarks among his praises of Physicians; thus: "Of medicines doth the apothecary

" make a confection; and of his works (qu. Bills?) there is no " end; and from him is peace all over the earth—(that is in the " scripture phrase, I presume, his patients are gathered to their " fathers, and are at rest.)

" He that sinneth before his maker, let him fall into the hand " of a physician."

Adieu: I leave you to study the science of cookery *en chimiste*. As for myself, if I cannot view it *en philosophe*, I will treat it at least *en amateur*. Moderate myself, I do not despise the bird's-eye view of a well spread table, though I can heartily coincide with Horace.

Si ventri bene: si lateri est; pedibusque tuis, nil
Divitiæ poterunt regales addere majus.

Observe, however, that Horace does not say simply, *si ventri*, that is if you have plenty to eat; but, *si ventri bene*, that is plenty of food *well cooked*. In my next I hope to peep with good effect, into the kitchens of some of my friends who know how to live.

EPICURI DE GREGE PORCUS.

Mr. CURWEN, who ought to be known under the title of the Northern Patriot, has recently circulated the following letter on the important subject of the culture of Potatoes.

" *Workington-Hall, April* 9, 1809.

" SIR,—The improvement of our agriculture appears to me to be the most certain means of advancing the prosperity and happiness of the United Empire, and preserving to us the blessings we enjoy. I may be deemed visionary, but I cannot disguise my opinion, that Great Britain, under a system of good agriculture, would be capable of supporting thirty millions of inhabitants. Nothing can contribute more to this desirable object than the general culture and use of Potatoes.

" The population of Workington is estimated at eight thousand, the weekly sale of potatoes during ten months of the year, exceeds four thousand stone* per week; to supply this consumption requires nearly an hundred acres; I am inclined to believe five times the number of acres would not, in any other mode of

* The common stone is 14lb. So that this is on a calculation of about 400 bushels to the acre, as a common crop: and in England it is so. I insert the next article about BUTTER, because the value of turnip-culture seems perfectly unknown in this country. T. C.

cropping, produce an equal quantity of food. In corroboration of this opinion, let us suppose five hundred acres of wheat, yielding twenty-four Winchesters, per acre, of 60lbs. or six hundred thousand pounds of bread, equal to supplying four thousand persons with half a pound of bread for three hundred days. The consumption then would be half a pound of bread to four pounds of potatoes. The comfort derived from the use of potatoes by the working classes, affords a most powerful argument in favour of their general introduction—no food is more nutritious, none so universally palatable. The philanthropist and politician will equally promote their views, by extending the use and culture of the potatoe.

" For eight years past I have fed all my working horses upon steam potatoes, mixed with cut straw, and latterly I have with equal success given them to oxen. They would answer for milch cows, and fattening cattle, if they could be raised at less expence. My consumption for eight months in the year is a ton and a half per day, or about three hundred and sixty tons annually—the land used, in feeding with potatoes as a substitute for hay, is between a sixth and a seventh—fifty acres of potatoes will furnish above the quantity required, whilst three hundred and fifty acres of hay would most frequently fall short of supporting the same number of working horses and oxen—the advantage of this system extends beyond the individual, and is felt both immediately and remotely by the mass of the community. In the first place, the ground heretofore indispensably requisite for the growth of hay, for horses is now applied to the purposes of a dairy, and in the last year 507,024 quarts of milk were sold, whereas in 1804, only 222,755. In years of scarcity, the food of horses can be applied to the use of man.

J. C. CURWEN."

BUTTER.

SEVERAL specimens of Swedish turnip butter, from the dairy of Mr. Ives, of Catton, were exhibited at the principal inns in Norwich, on the 15th of April; and being placed on the dinner tables at each house, gentlemen had a fair opportunity afforded them of pronouncing a decided opinion upon its quality.

It has afforded a convincing proof, that turnips of all descrip-

tions, do not universally, in a greater or less degree, injure the flavour of our milk and butter; to this assertion, the Swedish turnip is an exception, in a most decided point of view.

It appears, that the management of these cows is most simple and easy; they are fed on hay, good oat-straw, and Swedish turnips; but it ought to be observed, that a degree of care and neatness is necessary in preparing these turnips for them. In the first place, they are drawn about the end of February or beginning of March, laid in ridges or heaps of a load or two each, and left on the land for two or three weeks; they are then carted away to some convenient place, their tops and tails cut off clean, and piled on a heap, where they are kept as free from soil or dirt as possible. It is adviseable also, that the operation of topping and tailing be done in a yard apart from that where the cows are fed; for should they eat any of the tops, this excellence of flavour in the milk and butter will be deteriorated considerably. The mode of preparing these turnips deserves particular attention. The drawing them from the land at the time they are in their most compact state, then depriving them of the absorption, if it may be so called, of the new or vernal sap of the soil, a diminution of that important matter does not take place, as from an opposite course of management would be the result, to the no small injury of the following crop. In this state too, they keep much longer; and, moreover, which is of no less importance, the turnips are, in themselves, more nutritive, as would appear from the superior quality of the butter produced; for, by being thus exposed to the air, and detached from the soil, a considerable portion of aqueous moisture is carried off by natural evaporation, which would otherwise add to the quantity of our dairies, but not the quality, as we find to be the case in feeding cows with those which have been recently drawn. *Month. Mag. June* 1809.

TABLE.

From Professor Davy's Treatise on Agriculture, p. 131.

Table of the quantities of soluble or nutritive matters afforded by 1000 *parts of different vegetable substances.*

Vegetables or vegetable substance.	Whole quantity of soluble or nutritive matter.	Mucilage or starch	Saccharine matter or Sugar.	Gluten or Albumen.	Extract, or matter rendered insoluble during evaporation
Middlesex wheat, average crop	955	765	—	190	
Spring wheat	940	700	—	240	
Mildewed wheat of 1806	210	178	—	32	
Blighted wheat of 1804	650	520	—	130	
Thick-skinned Sicilian wheat of 1810	955	725	—	230	
Thin-skinned Sicilian wheat of 1810	961	722	—	239	
Wheat from Poland	950	750	—	200	
North American wheat	955	730	—	225	
Norfolk barley	920	790	70	60	
Oats from Scotland	743	641	15	87	
Rye from Yorkshire	792	645	38	109	
Common bean	570	426	—	103	41
Dry peas	574	501	22	35	16
Potatoes	from 260 to 200	from 200 to 155	from 20 to 15	from 40 to 30	
Linseed cake	151	123	11	17	
Red beet	148	14	121	13	
White beet	136	13	119	4	
Parsnip	99	9	90		
Carrots	98	3	95		
Common turnips	42	7	34	1	
Swedish turnips	64	9	51	2	2
Cabbage	73	41	24	8	
Broad-leaved clover	39	31	3	2	3
Long-rooted clover	39	30	4	3	2
White clover	32	29	1	3	5
Sainfoin	39	28	2	3	6
Lucerne	23	18	1	—	4
Meadow fox-tail grass	33	24	3	—	6
Perennial rye grass	39	26	4	—	5
Fertile meadow grass	78	65	6	—	7
Roughish meadow grass	39	29	5	—	6
Crested dog's-tail grass	35	28	3	—	4
Spiked fescue grass	19	15	2	—	2
Sweet-scented soft grass	82	72	4	—	6
Sweet-scented vernal grass	50	43	4	—	3
Fiorin	54	46	5	1	2
Fiorin cut in winter	76	64	8	1	3

All these substances were submitted to experiment green, and in their natural states. It is probable that the excellence of the different articles as food will be found to be in a great measure proportional to the quantities of soluble or nutritive matters they afford; but still these quantities cannot be regarded as *absolutely* denoting their value. Albuminous or glutinous matters have the characters of animal substances; sugar is more nourishing,* and extractive matter less nourishing, than any other principles composed of carbon, hydrogen, and oxygen. Certain combinations likewise of these substances may be more nutritive than others.

I have been informed by Sir Joseph Banks, that the Derbyshire miners in winter, prefer oat cakes to wheaten bread; finding that this kind of nourishment enables them to support their strength and perform their labour better. In summer, they say oat cake heats them, and they then consume the finest wheaten bread they can procure. Even the skin of the kernel of oats probably has a nourishing power, and is rendered partly soluble in the stomach with the starch and gluten. In most countries of Europe, except Britain, and in Arabia, horses are fed with barley mixed with chopped straw; and the chopped straw seems to act the same part as the husk of the oat. In the mill 14lbs. of good wheat yield on an average 13lbs. of flour; the same quantity of barley 12lbs. and of oats only 8lbs.

In the south of Europe, hard or thin-skinned wheat is in higher estimation, than soft or thick-skinned wheat: the reason of which is obvious, from the larger quantity of gluten and nutritive matter it contains. I have made an analysis of only one specimen of thin-skinned wheat, so that other specimens may possibly contain more nutritive matter than that in the table.

STEAM ENGINES.

SINCE concluding this article, a few pages back, new communications induce me to resume it.

I have already mentioned, that on a rail-way near Leeds in Yorkshire, in England, a waggon containing a steam-engine, drags after

* This may be: so thought Cullen; but I know of no experiments to prove this. T. C.

it twenty waggons, each containing three tons of coal, at the rate of four miles an hour. I find, that steam applied to draught carriages, has been used for some years in England, and the practice is extending.

It is with very sincere satisfaction, I announce, that several gentlemen of considerable mechanical abilities, in our own country, are now turning their attention to the improvement and construction of steam engines. Several drawings have been sent to me for opinion and publication, but at present, I can do no more than briefly notice the principles adopted.

In *Mr. Fulton's* engines, the method of packing the piston, of preserving the prependicularity of the stroke, of communicating the rotatory motion, and the form and dimensions of the unwieldy working beam, have been improved, since my time of observation.

Mr. French, of New York state, is also constructing engines, with some improvements on Boulton and Watt's, as I have heard, but I do not know exactly what the alterations are.

Mr. Oliver Evans's establishments in Philadelphia and at Pittsburgh, have early and greatly contributed to bring steam engines into use, but I do not accurately understand the point on which his claim to a patent right, is meant to rest. If I had the precise invention explicitly described, I should be glad to give it that currency, to which its novelty may entitle it.

Mr. Rodman, of Washington, South Carolina, has sent me the drawing of an atmospheric engine, working with two cylinders, which appears to possess considerable merit, as to the simplicity and consequent cheapness of the machinery. I do not remark any contrivance to preserve the perpendicularity of the stroke. The construction and situation of his valve, I understand, is much like the method adopted by Mr. French: but about this I am not able to speak with accuracy.

Mr. Ogden, of Pittsburgh, is also engaged on a steam engine, with two cylinders contiguous to each other. He proposes working his steam of whatever density, in two cylinders, to be stopt off at any point. If at one half, the instant one cylinder is half filled, its steam valve is closed, and the steam valve of the other is opened. On the first pistons arriving at the end of its stroke, that of the other cylinder will have performed half a one. Its steam valve will then be closed, and that of the first again opened, as well as its opposite condensing valve: in this manner the motion will be

regularly continued, each cylinder being alternately half filled with steam.

The pistons act simultaneously, at right angles with each other, and one is at its maximum when the other is at its minimum, so that there is no necessity for a balance wheel as a reservoir of power: for when one piston ceases momentarily to act, the other instantaneously continues the motion in the same direction. The power is communicated to crank wheels worked by shackle bars attached to each piston. If the steam be stopt off at one half, and left to act by its expansive force, the gain is half a cylinder full of steam at each stroke. There is nothing new in two cylinders, or in working by expansive steam, but the getting rid of the balance wheel by the simultaneous action of each piston in the manner above described, I *think* is new.

Mr. Latrobe of the same place, is erecting a manufactory for steam engines, in which he proposes to make some improvements on the construction of Boulton and Watt: but whether to be used solely for water navigation, or for sale, I know not yet.

So much exertion, and by such men, affords ground to hope that at no distant time, improvements may take place, that will put our Engineers of America, upon a par at least with those of England. But of all the attempts to vary from the common construction, I have seen none that promises so well, as those of Mr. *Dowers* of Philadelphia. I have carefully examined his drawings, and I think he has skilfully combined a series of improvements, that if put in practice, with great attention to mechanical accuracy, will go near to supercede every variety of steam engine now in use. These improvements contemplated for a double engine, consist in

1st. A more perfect mode of condensing, by the *joint* application of exposing a large and thin metallic vessel containing the steam, to the action of cold water, as the Rev. Mr. Cartwright proposed——and the common method of condensing by injecting the spray of cold water. A plan nearly similar to Mr. Dowers' condenser, is suggested, p. 82 of this Volume.

2ly. Using perpetually the same water, for the boiler, the condenser, and injector; without diminution or the necessity of addition; except what may arise from imperfections in the workmanship of the vessels. In which it is not easy, always to guard against steam leaks, and water leaks. The wormanship being good, this engine must work with a smaller supply of water than any other yet known.

3ly. A more certain mode as I think of discharging the air. It arises to the top of the water, and is thrown out by the valves that open with the upward stroke of the piston that throws the cooled water into the condenser.

4ly. A new, and seemingly effectual method of keeping the water at a regular height in the boiler, by making the condenser discharge any surplus into the boiler.

5ly. Saving and condensing the steam occasionally discharged from the boiler, and which in other engines escapes into the air, so that the boiler and condenser being once supplied with water, this stock of water is not diminished by waste steam, or encreased by extraneous injection water: or varied, except as need may arise from causes depending, not on the principle of working the engine, but from accidental and unavoidable imperfections and wear in the materials and workmanship, or perhaps from slight decomposition of the water itself.

6ly. Boilers on a new, and if the workmanship can be depended on, an improved construction: not much differing in principle, but greatly in form and arrangement from those hitherto employed: being two large boiler-cylinders through which the fire flue runs, and which are furnished with a series of pipes, and one small boiler-cylinder in the centre, over which is a cylindrical reservoir for the steam.

7ly. A rack, or cog-wheel with a handle, by which the cars or plugs, of the plug beam, may be moved and varied at pleasure: so as to *regulate* as need may require, the opening of two steam-valves, additional to the valves of the common engine: and by this means, to stop off the steam at any given point or portion. In Watt's engine this is managed by a pin. By means of this regulator, if a fourth part only for instance, of the cylinder full, be thrown in, it can act by its expansive force. So that no steam need be employed, beyond what is necessary to the required work of the engine. The regulating valves, are on a construction different from the common valves, being worked by rods, one within the other. The steam admitted, is also admitted at once, not gradually; which last practice although recommended by Woolf and now common (see p. 186 of this vol.) has disadvantages.

8ly. A new method of *augmenting* the force of steam, by exposing to considerable heat, a part of the steam that acts on the piston, and mixing it with the steam that proceeds direct from the boiler. Compare this with Mr. Woolf's patent, page 190 of this volume.

9ly. A method of superceding the necessity of a fly wheel, by means of two circular crank and cog wheels attached by shackle-bars to the pistons of two cylinders. The crank wheels are cast in the same mould, and move a smaller cog wheel in the centre; so that, when the piston in one cylinder has arrived at the bottom, the piston in the other, is just commencing its descent, and vice versa. The combined force of the pistons in each cylinder, being always the same. Here, no reservoir or accumulation of surplus force in a fly wheel, is necessary to carry the motion past the perpendicular pressure; because, the instant one of the pistons with its attached crank wheel, has spent its force on the middle cog wheel, the other piston with its attached crank wheel, begins to act; driving round the centre cog wheel in a similar and uniform direction. The two large wheels between which the smaller is placed, are connected together by a small beam or brace. This invention is contested by Mr. Ogden; and with the dispute, I have nothing to do. It is worth while however, to compare it with Mr. Cartwright's method of communicating rotatory motion; see p. 84 of this volume.

Mr. Dowers proposes making the valves of the common engine, answer the purpose of his regulating valves. If so, so much the better. There are practical difficulties attending the construction of the boiler, and the augmenter; but they are not insuperable.

If alcohol or ether, or any mixture of alcohol and water, can be used economically in steam engines, as good judges think may be done, this engine will afford the means of using it. But I know of no decisive experiments yet made on this important subject. Mr. Dowers, and I, in my laboratory, past whiskey diluted with from one half to two thirds water, through a red-hot gun barrel, but the gas produced, was small in quantity and not inflammable. It was in fact no more than the air contained in the gun barrel.*

The wasteful and unscientific practices of using steam little higher than to afford mere atmospheric pressure thus neglecting the force to be gained by a small addition of fuel†——and of gene-

* The inside however had been previously oxyded.

† It is surprising that Mr. Watt who first discovered and demonstrated (see p. 93, and 171 of this volume) that the elasticity of steam being in proportion to its density, its expansion when stopt off at 1-4th, 1-3rd or 1-2 the capacity of the cylinder will produce a power in a much greater ratio than 1-4th, 1-3rd or 1-2 of the whole, should have made so little use of this discovery in his steam engines. The time is approaching when steam of great

rating steam of high temperature and great expansive force, to waste itself in the open air, and in its exist to be counteracted by the resistance of the atmosphere, are thrown aside. The faults both of the European and the American engines, are in a great degree obviated; and we may expect from American ingenuity, a more perfect engine than has yet been devised.

The engine in contemplation, will act by steam at high temperature, as Watt suggested, and Trevethick practised on a large scale: it will act by expansive force as has long been the practice in many English engines; and by two cylinders: so as to combine the modern improvements, and obviate modern defects. How far Mr. Dowers has been indebted, if at all, to his predecessors, the readers must judge by the references I have made to former pages of the present volume.

I shall indeed rejoice to see some American by and by, still improve upon his ideas. T. C.

NOTICES.

Stone Coal. Judge Gibson, of Luzerne, has written me the following letter.

Wilkesbarre, February 23, 1814.

DEAR SIR,

I send you a likeness of one of your friends. There is nothing remarkable in it, except that it is done with the *stone coal* of this place, instead of Indian ink. It is prepared for use by rubbing a bit of it on a fine hard stone in gum water, just thick enough to hold the particles in suspension; it is then laid on in the usual way with a camel hair pencil. By comparison with a drawing in

force will diminish the size of boilers; when unwieldy beams and ponderous fly wheels will be disused; when single engines will give place to double, when expansive power will be used to the utmost; and when no steam will be generated to be thrown away. As yet, I dare not anticipate the time, when water will be laid aside, and alcohol, ether, alkaline gas or hydrogen be substituted in its place. Alcohol and ether are condensible at low temperatures——Ammoniacal gas by the vapour of muriatic acid——and hydrogen by firing it with oxygen, and converting it into water. These are speculations; and so was at one time, the steam engine itself. T. C.

Indian ink, you will, I doubt not, give the preference to the coal, as it will be found free from a brownish cast, always perceivable in the former. The harshness observable in the inclosed drawing arises from the extreme badness of the pencil I was obliged to use, and not from the quality of the ink, which is susceptible of the greatest softness.

The coal is found to be superior to lamp or ivory black for paint, printers ink, and blacking leather. It also makes the best writing ink for records that has yet been discovered. The colour is deeper, and is not in the least affected by the oxy-muriatic acid, or any other chemical agent, and must remain unaltered by time. The application of coal to these purposes was discovered by Mr. Jacob Cist of this place—he has obtained a patent.

Very sincerely your friend,

JOHN B. GIBSON.

Thomas Cooper, Esq.

The only objection to the preceding account of the uses to which stone coal may be put, is, that whatever mucilaginous substance be used to fix it on the paper, water can wash it away. But that it will afford a colouring matter unattackable by any acid, and unalterable by any time, cannot be doubted. The discovery is of importance. T. C.

Platina. Dr. Bollman, whose ingenuity and perseverance upon this subject deserves well of the public, has succeeded in giving a plating of platina to iron, of which I have a specimen. Also I believe to copper. The use of this metal will be extended to many manufactures.

He has succeeded in giving the mercurial-coloured metalline coating to porcelain with platina. He will by and by introduce it into the glassworks, if not in the form of crucibles (which can be done) at least to furnish an unoxydable smooth plate, on which the glass blower can work his vessel. It promises, in his hands, to become a very important object to the useful and ornamental arts.

Statistics. The following table has been inserted in two or three of our daily papers. The last number of the sixth column has been printed 16,452,656. This must be a mistake. I have inserted six instead of sixteen, for reasons obvious on inspection. In my former number, I stated, by conjecture, the poor rates of Great Britain at six millions sterling, in round numbers. I was about half a million too low.

British Statistics. The following table, exhibiting a concise and striking view of the internal condition of England, is extracted from a British paper of 16th October, 1813.

A TABLE

Exhibiting at one view the depreciation of our currency, the disproportion between the advance made in the price of labour and the fall which has taken place in the value of money; with its consequent progressive pauperism, from the revolution of 1688 *to the year* 1812.

Years.	Price of bread.	Value of the pound in quartern loaves.	Average money wages of husbandry labor.	Bread wages in quartern loaves.	Poor rates.	Number of Paupers.
1687	3*d*	80	6*s*	24	*l.* 665,362	563,964
1776	6½	37	8	15	1,523,163	695,177
1785	6	40	8	16	1,943,649	818,851
1792	7	34	9	15	2,645,520	955,326
1803	10	24	10	12	4,113,164	1,039,716
1811	12	20	12	12	5,922,954	1,247,659
1812	20	12	15	9	6,452,656	2,079,432

This is not inconsistent with the account I have given in page 251 of this volume.

The peck loaf ought to weigh 17 lb. 6 oz. Therefore the quartern loaf ought to weigh one fourth of this, or 4 lb. 5½ oz. Every sack of flour is to weigh 2½ cwt. net weight, or 280 lb. and out of this ought to be made 20 peck loaves. When the price of grain rises, the magistrates who set the assize of bread, allow the quartern loaf to be diminished in weight. Fine wheaten bread, is allowed to weigh but three fourths only of the weight required for household bread.

The following table is from Niles's Register.

COMPARATIVE STATEMENT

Of the Population and Land Forces of different states at present engaged in the war.

Names of the States.	Population.	Land Force.	Remarks.
			or about
Empire of Great Britain	16,531,000	306,760	1 in 54
Russia	42,218,000	560,000	75
Austria	20,216,000	320,000	63
Kingdom of Prussia	4,984,877	250,000	20
Sweden	2,326,000	45,000	44
Spain	10,396,000	100,000	104
Portugal	3,550,000	30,000	118
Sicily	1,656,000	10,000	165
Duchy of Warsaw	3,774,462	30,000	126
Total	105,601,339	1,651,760	764
Deduct for troops indisposable (indisposable en Francoise) from			
Great Britain 150,000			
Russia 260,000			
Austria 100,000			
Prussia 50,000		560,000	
Remain	105,601,339	1,091,760	
Empire of France (including all the new departments	42,316,000	590,000	1 in 7
Kingdom of Italy	6,719,000	40,000	16
Kingdom of Naples	4,964,000	16,000	31
Republic of Switzerland	1,638,000	15,000	10
Confederation of the Rhine	13,560,120	119,000	11
Kingdom of Denmark	2,509,600	74,000	3
United States of America	6,800,000	20,000	32
Countries not included in the above			
Part of the country of Katzenelubogen	18,000		
Principality of Erfurth	50,330		
Illyrian Provinces	110,000		
Total,	78,385,050	874,000	89
Deduct for troops indisposable from France		190,000	
Remain	78,385,050	684,000	
Balance in favour of the allies	27,206,289	407,760	

It is mentioned as a remarkable event, that within these three weeks there has been more new accounts opened at the bank of England, than there has been for the four preceding years, principally by foreigners. *London paper.*

British Revenue. An official account laid before the house of commons, states the amount of the net produce of the permanent taxes in Great Britain for the year ending the 25th of October, 1812, at 38,743,428*l.* 16*s.* 8½*d.*; and for the year ending the 25th of October, 1813, at 37,833,366*l.* 12*s.* 1½*d*,; being a deficiency of about 900,000*l.* The same account states the total amount of the net produce of the war taxes, for the year, ending the 25th January, 1812, at 21,822,532*l.* 14*s.* 10¼*d.*: and for the year ending the 25th October, 1813, at 22,740,568*l.* 4*s*, 0¼*d.*; being an increase to about the amount of the deficiency in the permanent taxes. Thus the net produce of the public revenue of Great Britain, for the year ending the 25th of October, 1813, is 60,573,934*l.* 16*s.* 2*d.*

To 60,573,934*l.* add the poor rate 6,452,656 the amount will be 67,026,590*l.* sterling levied on the country, beside tythes and other ecclesiastical sources of taxation.

In 1812, the income tax was considered as somewhat short of 13 million, including arrearages due. At ten per cent. this would be levied on an estimated income of 130 millions. Hence, on the average, every man in Great Britain, pays one half at least, of his income in taxes. I do not want to be perpetually harping on foreign commerce, and the wars it induces, but surely it well deserves to be considered, how much of this enormous taxation can fairly be imputed, directly or indirectly to that source.

I meant in the present volume to have given an account of French statistics. I shall remit that, till the publication of Mr. I. T. Naylor's book.

So of the United States statistics, I shall be able to give a better view of this subject, after the recess of congress and our state legislatures.

Dyeing. My booksellers hasten to inform me, that a translation of Berthollet on dyeing is about to be published. Also a new edition of Dr. Bancroft's book on that subject. No one has done so much to elucidate the theory of dyeing as Berthollet and his son. Dr. Bancroft's experiments, though principally made (at least in his first volume) to extend the sale of his quercetron bark (the bark of the black oak *quercus nigra*) are of importance. I expect something from the new edition. I think all persons interested in the art of dyeing, will purchase both books. But when I come to that article, which I may probably treat of earlier than I at first intended, I shall endeavour to make it the interest of persons concerned in the art of dyeing to purchase also the Empo-

rium that contains it; but I am not anxious hastily to publish my collections, for fear that many if not most of the facts and processes may be forestalled by these proposed publications. I hope to make that article when I come to it, a good one; which I cannot, without looking at the latest sources of information. T. C.

Potatoes. I consider the paper of Mr. Curwen on this subject, so fully corroborated, and in a manner so very different, by the experiments of Professor Davy, as very important. If an acre in potatoes yields but *twice* the weight of produce, as an acre in wheat, it affords an equal weight of nutriment. But an acre in potatoes equally well managed, will afford near *twenty times* the weight: nor is there great difference in the expence of cultivation; for potatoe ground highly manured, is the very best preparation for a wheat crop. In my neighbourhood in Lancashire and Cheshire, potatoes (when an early and a late crop were raised for the Manchester market) would justify twenty pound sterling, a Lancashire acre (about $\frac{1}{3}$ more than a statute acre) in manure. The inferences in respect of national as well as individual saving from the facts stated, are of the very first moment. T. C.

Lightning. The following cautions respecting the danger that may occasionally arise from lightning, are sufficiently obvious, but they deserve to be frequently brought into notice. T. C.

In storms of this kind we are frequently, from inadvertence, exposed to imminent danger, when a timely, and in general a very practicable, mere change of station would secure us against it.

It has been long known that the cause of thunder, is the same with that which produces the ordinary phenomena of electricity; thunder being no other than a grand species of electricity, or, rather, that electricity in the hands of man is a feeble imitation of thunder from the hand of the Almighty. A thunder-cloud may be considered as a large conductor, actually insulated and surcharged with electric matter; which, should it meet with another cloud not electrified, or less so than itself, will discharge part of its subtile fluid into the latter, by flashes of lightning and formidable reports of thunder; until an equilibrium of quantity be restored.

Whether this principle, the electric fluid, actually emanates from the sun, and commixes with our atmosphere, as some philosophers conceive; or whether it is a principle inherent in the earth and its appendages, *per se*, is a question not necessary to be

here discussed: certain it is, that we find it abundantly diffused through the atmosphere, and on the surface of the earth, and on various bodies attached to the earth: we know also that some kinds of bodies will convey this fluid with greater facility than others will. Such bodies as most readily convey it from object to object, are called conductors: the most common of which are all metals, in the following order of perfection; gold, silver, platina, brass, iron, tin, and lead; metallic ores, the fluids of animal bodies, water, ice, snow, green wood, and most earthy substances. There are other bodies which will not, without difficulty, conduct it; and which, on that account, are called non-conductors: such are glass, sulphur, resin, silk, cotton, feathers, wool, hair, paper, ashes, and most hard stones.

From hence it may be inferred that, in dangerous thunder weather, we should carefully avoid standing or sitting in contact with any of the conductors.

By dangerous thunder weather, I mean such storms as are over our heads or near to us. The distances of which may be nearly ascertained, by the known progress of sound through the air, which is at the rate of about 381 yards in a second of time; so that if there are nine beats of a clock, or ten of the pulse of a person in health, between a flash of lightning and the report of thunder, the distance is then about two miles, and no danger is at hand; but if no more than about four beats of a clock, or five pulsations, are between them, danger may be apprehended, and precaution should be taken.

In the open air, standing under tall trees, especially such as have dead or dry branches, or against very lofty buildings, is dangerous.

As lightning runs swiftly along, or plays amongst metallic bodies, let care be taken to avoid all such, whether out of doors or within.

All doors and windows of apartments should be set open, that lightning may have free passage through.

A sitting or recumbent posture on chairs, mattresses, couches, or beds, filled with hair, wool, or feathers, in such part of a room as may be out of the influence of conductors, or may not be in the way of any current between windows and doors, is, undoubtedly, the safest situation that can be chosen.

The furniture of the fire-place should be carefully avoided.

So, also, should the wires and cords of bells.

Picture-frames, and other furniture gilt, are unsafe to stand close by. A most remarkable effect of lightning, in gilded rooms happened in the hotel occupied by Lord Tilney, at Naples, in the

year 1793. The apartments were decorated with great elegance, as was the taste of persons of rank in that country: the cornices of the room were gilt, in the Italian manner, from whence proceeded a number of plat-bands, serving as frames to the tapestry, gilt likewise; so also were the borders of the pannels of the wainscot, the frames of pictures, mirrors, and door posts.

On the 24th of March, Lord Tilney had a numerous party at dinner. A loud clap of thunder alarmed the company, and in an instant the whole apartment seemed to be on fire. Every one thought himself struck by the lightning; but, to their great joy, no one was wounded; for the prodigious quantity of metal conductors enabled the lightning to pass, without injuring any one.

On examination, it was found that great part of the cornices were damaged, particularly at the corners, and where bell-wires passed through; picture frames much injured; and some of the bell-cords burnt.

By these facts, we have clear testimony that the electric fluid most readily attaches itself to metallic conductors; which in this instance, were the means of saving the company from destruction; had any of them, at the time, been in contact with these gaudy trappings, it is probable that their lives would have been the sacrifice. A. C.

Cloaths catching fire. Muslin dresses and silk stockings, with midnight dances, have set the consumption at the head of all disorders in point of frequency and mortality.

Muslin dresses, and open fire places, have destroyed many a valuable and much lamented female, by the most painful of deaths. There are one or two plain, common-sense remarks that deserve to be borne in mind.

Fire will consume a piece of muslin placed over it, much more rapidly than one placed on the same horizontal line or plane. The instant a female finds the fire has caught her cloaths, she should throw herself down, and cover herself with the carpet, or the woollen cover of a table; the very position alone, will afford time to extinguish a moderate flame, even without a carpet.

If a person be near, the fire may be extinguished, by turning up and folding up in a tight roll the garment that has caught fire. T. C.

END OF VOLUME II.—NEW SERIES.

Alexander & Phillips, Printers, Carlisle.